

THE INFORMATION MILLENNIUM:

**ALTERNATIVE
FUTURES**

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INFORMATION INDUSTRY ASSOCIATION

THE INFORMATION MILLENNIUM: ALTERNATIVE FUTURES

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by

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PREFACE

by

Robert Weissman
President
The Dun & Bradstreet Corporation

The world has entered an information age and information is fast becoming the critical resource upon which individuals, organizations and nations rely for their own development and their place in the sun. We who are privileged to be part of the information industry are directly involved in a revolution whose impact may well transcend the two great earlier socio-economic transformations, the agricultural revolution and the industrial revolution. Individuals and institutions will be profoundly affected and in more ways than we can now imagine.

Managing these changes constructively is a daunting challenge. Those of us in the information industry have a special responsibility not only to our companies but to society as a whole. We are part of the revolutionary process. What we do or fail to do is going to make a difference. The key marketplace decisions that we make and the public policy framework which we can help to create, or allow to be created by our inaction, will determine the shape, structure and quality of life in the information age.

Concerned as most of us are with the overall implications of the information revolution, the day-to-day responsibility of running our own companies does not leave us with much time. And time is needed to focus in depth on the long term direction of our industry and the public policy framework in which it can most effectively operate for the good of all. That fact prompted me in February of 1985, on behalf of Dun & Bradstreet, to encourage the Information Industry Association to undertake the task and to offer financial support.

This report, The Information Millennium, is the first step in that undertaking. It describes the technologies, applications, social implications and public policy issues emerging from the nascent information age. But it is more than just a snapshot. The authors, Clement Bezold and Robert Olson, have also tried to look ahead and forecast where we might go in each of these areas. Since there is no single, clear pathway the future might take, the forecasts are combined into four alternative scenarios for the information industry and society in the year 2000.

In its depth and breadth the report is a rich compendium of relevant facts, perceptive insights and possible directions relating to our industry and its role in the world. None of us is likely to agree with all the observations presented in the report. Yet, a careful reading will help all of us better understand our own industry and its pervasive role in the world. So viewed, the report should prove to be helpful background material in developing our own corporate long term strategic plans. At the same time it will provide more specific guidance to information industry leaders working through the IIA to develop national and even worldwide information policy in the decade ahead.

As the alternative scenarios in the report indicate, there are some optimistic and some pessimistic possibilities ahead of us. The challenge is to crystallize our vision of the information millennium and to do what we can to try to bring about the kind of information society that we believe will most fully realize the incredible promise of the information revolution.

ACKNOWLEDGMENTS

This report was prompted by Robert Weissman's challenge to the Information Industry to ensure that the Information Revolution is a boon, not a bane to mankind. Support for this project was made available by an initial grant to IIA from Dun & Bradstreet which was supplemented by the Pacific Telesis Group. This report seeks to enable members of the Information Industry Association and other readers to better understand and prepare for the threats and opportunities that will arise in the years before the Information Millennium begins. In taking on this challenge, the Institute for Alternative Futures (IAF) began by soliciting the intellectual contributions of many experts inside and outside of the industry. To the extent that we have succeeded in showing the major pathways the industry and its environment might take in the years ahead, we owe that success to those who contributed their time and their thinking to this report.

We wish to thank those individuals listed in Appendix 3, whom we interviewed during the course of this project. While these individuals and those in the organizations mentioned below were essential to the development of this report, this does not indicate that they (or their organization) agree with what we have writtten. We bear responsibility for what has been produced.

Preparing for the future is fundamentally a learning process. Consistent with IAF techniques, we decided at the outset to involve the IIA membership in the process. During 1986, the IIA meetings became a place for us to learn more about the industry. This was accomplished by workshops and briefing meetings (attended by over 120 individuals) at the IIA Boca Raton meeting in February, at the Mid Year Meeting in Denver, the Impact Conference on the CD-ROM in Palo Alto, and at the Impact Conference on Knowledge Systems in Cambridge. We also conducted numerous interviews and had extensive discussions with the presenters and other experts at those IIA Conferences. In addition, the Project was advertised in Information Times and numerous IIA members took the opportunity to review a preliminary draft.

Four organizations also made special efforts to assist in the development of this report. Dataquest, at the instigation of Ralph Finley, held a session where their product vice presidents developed technology forecasts on the year 2000. These original forecasts are contained in Section 2. Vernon Tyerman of the Pacific Telesis Group twice assembled a cross-company team to assist in developing the technology and application forecasts. A group at LINK Resources, led by Steven Sieck, also reviewed and elaborated on some of the forecasts in Section 3 on the information industry and applications. Frederick Weingarten's division in the Congressional Office of Technology Assessment reviewed Section 5 on Policy Issues.

Other experts who were particularly helpful were Christopher Burns, Hubert Dreyfus, Haines Gaffner, Alan Kay, Joseph Laird, Michael Lenaghan, Nicholas Negroponte, Chuck Tower, Michael Tyler, Paul Zurkowski and Paul Shay. In addition several futurists shared their comments with us including Harlan Cleveland, Joseph Coates, Vary Coates, James Dator, Willis Harman, Michael Marien, James Ogilvy, and John Platt.

There has been a core group of IIA board members and staff who have guided us throughout the project, particularly John Jenkins and Kenneth Allen.

From the IAF staff we would like to acknowledge the research and logistical support of Annette Gardner, Jane Asfeld, Katherine Scott, and Sandra Tinter.

EXECUTIVE SUMMARY

The year 2000 marks the beginning of the information millennium - an era in which information is the key strategic resource. There are many possible pathways that society and the information industry may take into the future. This report summarizes trends in technology, applications, social impacts, and public policy, and integrates this information into four scenarios or alternative futures. The report is a first step in the Information Industry Association's Project on the Future of the Information Business, aimed at ensuring that its member companies understand the threats and opportunities of the years ahead.

Introduction

Section 1 shows that changes now underway in information technology represent a jump in capabilities comparable to the development of writing and printing. These technological changes are converging toward nearly universal information access, and are being paralleled by equally profound social changes. These enormous changes, happening simultaneously in a period of one or two lifetimes, are unprecedented in human experience. Our decisions and actions will determine whether these changes will be beneficial or harmful. In this environment foresight is essential. The information industry needs to lead change rather than follow it. This requires the creation of strategic visions for individual companies and for the industry as a whole.

Technological Capabilities in the Year 2000

Section 2 concludes that today's phenomenal rate of progress in microelectronics and information technology will continue through the end of the century.

Detailed forecasts are impossible, and surprises are inevitable, but it is possible to develop extrapolative forecasts for general technological capabilities likely by year 2000. Examples include 10-100 million components on an integrated circuit chip, contrasted to nearly 1 million today; 10-40 MIPS microcomputers, compared to 1-3 MIPS today; parallel architectures; 3 gigabytes storage on read-write-erase compact disks; extensive use of expert systems; an end-to-end digital phone system; and effective speech recognition and synthesis.

There are also many possibilities for breakthroughs that would provide even greater capabilities by the year 2000. Examples include wafer scale integration, increasing chip size by a factor of 10 to 100; neural networks that replicate the way neurons interact in the brain; optical transistors with switching times thousands to millions of times faster than today's transistors; and new approaches such as frequency domain optical storage or electron beam (E-beam) storage that could put 50 gigabytes on a compact disk.

Applications and Industry Changes

Section 3 explores new applications for both business and residential markets. Despite dramatic technological progress, the information industry will become less technology-driven and more market-driven.

Examples of new applications in the business/productive sector include: sophisticated simulations for worker training and decision support; expert systems for a wide variety of business settings; "hypertext," which summarizes huge bodies of knowledge in the most appropriate form for the user; language translation assistance; and speech recognition/synthesis systems capable of automating much customer interaction.

In the household/consumer sector, penetration of electronic transactions and services will be aided by revenues from advertisers and vendors. The

state-of-the-art "smart house" of the year 2000 will have 30-40 computers contained within its "smart appliances," its enhanced telephone system, and its home information center. These technologies will be used for home management, health care, education, and shopping.

The Information Industry

Among information companies, traditional business boundaries will continue to blur as a series of "megatrends" shape the development of the information industry. The megatrends include the globalization of the information marketplace, industry integration, tougher competition, and the growing importance of marketing. As information technology becomes even better and cheaper it will also be more interoperable, and there will be fierce competition between storage and intelligence on the network vs. onsite. As technology and communication capacity decrease in cost, the strategic importance of the content of information will grow.

These "megatrends" lead to our optimistic forecast, in which the information component in the business/productive sector will grow about twice as fast as the economy as a whole, because of continuing information sector contributions to productivity growth. In the household/consumer sector, information market growth roughly parallels growth in the economy as a whole.

Societal Impacts Of The Information Revolution

Section 4 shows that the information industry will make choices that play a major role in determining the kind of information society we create. The literature on social impacts of new information technologies contains many contradictory assertions. For example, will the information revolution give us: 1) more jobs or fewer jobs? 2) centralization or decentralization? 3) humanization or dehumanization? A closer look at the issues of education and employment suggests an important lesson: what happens will depend more on

the larger context of value choices and decisions by business and government than on any deterministic "technological impacts" on society.

A second way to examine societal implications of the information revolution is to consider the forecasts of social theorists who focus on the "information society" in relation to other major changes. Some authors believe we are passing through a transition as great as the largest changes of the past, comparable to the invention of agriculture and the Industrial Revolution. These social theorists also warn of ways the information revolution and society could "go wrong," such as persistent poor performance of the economy, serious information technology malfunctions, or a shift toward a more authoritarian society where information technologies are used for social control. These contrasting positive and negative images of the future form the basis of the scenarios in Section 6.

Information Policy

Information policy will be of critical importance in shaping the future of society and the information industry. Four key information policy issues are discussed in Section 5: privacy protections, the role of the government, intellectual property rights, and information literacy. These issues will affect the health of the economy and the protection of our freedoms. While these are public policy issues, the private sector will play a major role in defining and resolving them.

Privacy is the issue with the greatest potential to take the information revolution in dangerous directions. Emerging developments in computerized record systems, networks, computer matching and profiling, and electronic surveillance create new technical potentials for abuses of privacy. Despite developments in Federal and state laws in the 1970's and 1980's, no integrated set of laws exists to protect individual privacy.

The role of government as a competitive provider of information in the marketplace may grow as agencies search for cost recovery options. As new technology blurs the line between producing information and adding sufficient value for that information to be usable, government agencies could compete more easily with private value-added firms. The role of government in goal-setting and foresight needs to increase. Given a shared positive vision of the information society, the overall role of government in the information marketplace could decrease with a strategy of "low government intervention/high coherence of policy."

Intellectual Property Rights can be protected through a variety of legislative and judicial options, and through other safeguards such as unfair competition standards. Other major options, favored by a majority of the public, rely on marketplace approaches. These include developing codes, standards, and technological fixes (eg. electronic protections in software or data files). "Pay-per-use" systems based on optical storage could ensure that authors and publishers are rewarded and provide public access to vast information sources.

Information literacy is a critical factor for the success of the information revolution. The key issue facing our society is a creativity gap; tremendous information resources now exist to stimulate creativity and social problem-solving, but the average person knows little about them. Some foresee the possibility the emerging information technologies will create a "new literacy" that could alter our patterns of thought as profoundly as the shift from oral cultures to the literacy of writing. The information literacy issue also has an equity component, but any additional "information gap" involving new technologies will be a minor problem compared with the ten million adults who today lack the information skills of a competent 4th grade student.

By the year 2000 there will be a host of other issues, and several of these issues will require the information industry to extend its efforts to develop its own foresight.

Alternative Futures For The Information Industry

Section 6 presents four alternative futures for society and the information industry. Their purpose is to describe a range that bounds the major possibilities for the next fifteen years.

The High-Tech Information Society is driven by a booming economy, traditional American achievement values, and advanced information technologies which are rapidly incorporated into new products. This allows the information industry to grow at twice the rate of the GNP, rising to about 2% of sales across industries. Applications include full office automation, sophisticated simulations for training and decision support, and speech recognition and synthesis used for routine customer interaction. "AI agents" and "hypertext" devices automatically access and format information into its most appropriate form for the user. Privacy proves not to be a major problem. The role of government declines, particularly as a competitor in the marketplace. Basic information literacy is high. Copyright issues are resolved primarily in the marketplace, with little additional legislation or regulation.

The Creative Society also assumes rapid technological progress and a dynamic economy. In this scenario, however, the information revolution combines with a profound change in values: more expressive, socially concerned values lead to a recognition that human creativity is the heart of the information revolution. Enhanced productivity is sought not only for financial success but increasingly for the personal growth and social advancement it can make possible. A strong emphasis on basic research provides breakthroughs in neural networks, parallelism, and knowledge

representation. Privacy is protected diligently by the industry and by government. Government intervenes less in the information marketplace, while its policies become more coherent and far-sighted. Business applications include those in the "High Tech" future. Home information use grows even faster than GNP. Public libraries flourish as they foster new CD-ROM based pay-per-use approaches that adequately compensate authors and publishers and make massive amounts of information widely available.

The Things Bog Down scenario assumes slow technological progress exacerbated by AI failures in business and the military, weak consumer demand, and unresolved domestic and global problems (e.g., increased chronic unemployment, precipitous debt defaults). Even in this scenario there are still major technological advances. Privacy problems worsen. Hard times lead government agencies to raise money through information sales. Copyright enforcement becomes more difficult. Information gaps between rich and poor do not create poverty, but they amplify existing inequalities.

1984 and Beyond is a pessimistic scenario. Economic hard times combine with an AIDS epidemic and terrorist incidents to lead the public to accept much greater discipline and surveillance. Increasing digitization of the exchanges of daily life facilitates government imposed social controls. Technological progress slows in the late 1980's but rebounds as the more disciplined economy grows through the remainder of the 1990's. Business applications of information technologies are extensive. Public indifference to many small privacy intrusions in the late 1980's and the growing terrorist threat allow surveillance on a large scale to be put in place. At that point privacy becomes a non-issue. As the government puts it, "those who do nothing wrong have nothing to hide." The government simultaneously stimulates and

subtly censors the information industry. New copyright concepts give the government more control. A "freedom fighter" underground of computer hackers emerges.

Alternative images of the future provide a powerful tool for coping with the future's inherent uncertainty. Thinking in terms of a range of scenarios can help identify uncertainties and clarify unexamined assumptions about "what will be." It can stimulate your imagination to create new options for decision and action. It can help you make more conscious choices about what you want the future to be like. Alternative futures can help you explore adaptive, robust business strategies that work across a wide range of future conditions. They can be used to formulate a strategic vision and can provide a common language for communicating that vision throughout a company.

We hope that these images will stimulate you to think more systematically about the quality of the future that you want to help create.

1. INTRODUCTION

THE IIA PROJECT ON THE INFORMATION BUSINESS OF THE FUTURE

This report, The Information Millennium: Alternative Futures, is the first product of a project on "The Information Business of the Future: A Strategic Planning Process" developed by the Information Industry Association in cooperation with the Institute for Alternative Futures. The report is a response to Robert Weissman's challenge to the information industry to ensure that the information revolution proves a "boon, not a bane" to mankind. The project is intended to clarify the nature of the information revolution, the different pathways it might take, and the role the information industry can play in steering it wisely. The Project seeks to identify key trends shaping the information arena in the areas of technology, applications, social impacts and public policy; to provide members of the information industry with a common set of scenarios for strategic planning; to encourage and sustain a dialogue within the industry and among key experts and public policy officials; and to provide a long-range focus for IIA conferences and publications.

THE INFORMATION MILLENNIUM

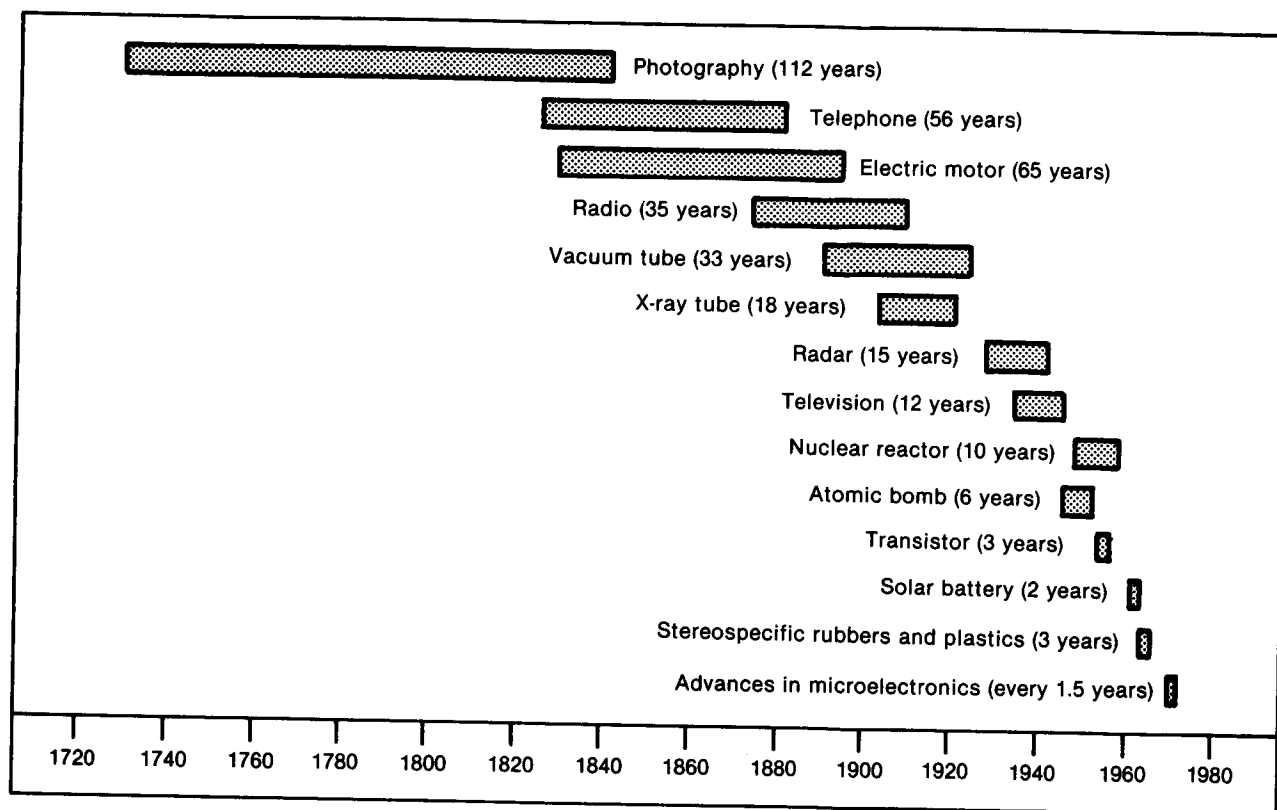
Terms like the "information revolution" and the "information society" are often used loosely, but there is a reality behind them; a technical, economic and social reality.

The information revolution is a technical reality. Driven largely by developments in microelectronics, information technology is advancing at a rate unprecedented in the history of technology. As Figure 1-1 indicates, advances in microelectronics are taking less time to go from discovery to application than any other area of technological development. Our analysis of emerging technological capabilities in Section 2 below indicates that the rate

of technological improvement experienced since 1970 will continue through the year 2000. Wireless communication, wire communication, and optical fiber are all being interconnected into a vast globally-integrated grid capable of carrying data, text, pictures and video as well as voice communication. Computers are rapidly becoming more powerful, faster, smaller, cheaper, and easier to use, and we are moving into computer applications that can reasonably be said to have "artificial intelligence." Computer technology and communication technology are themselves merging into a new technology of "telematics" or "intelligent networks." In terms of technology, we are still at the beginning, not the end, of the information revolution.

The information revolution is also an economic reality. As we show in Section 3, there are many different definitions of the information industry valid for different purposes: a \$1.6 billion provider of data, largely electronic; a \$2.3 billion "electronic publishing industry;" a \$15 billion "information vending industry;" an \$11 billion "media industry." In the broadest sense, the information sector of our economy was recently estimated to constitute 34 percent of the gross national product (GNP) and 41 percent of the nation's labor force in 1980 (1).

Figure 1-1: The Speed of Technological Change: Intervals Between Discovery And Applications In Physical Sciences



Source: John McHale, World Facts And Trends, New York:Collier Books, 1972, p. 3. as cited in Magda Cordell McHale, Facts And Trends: The Changing Information Environment: An Information Chart Book, Center For Integrative Studies, SAED, State University of New York at Buffalo, used with permission.

Many thoughtful observers believe that we are passing through a historic economic transition from an economy based primarily on "mass" (physical resources, especially energy) to an economy based primarily on information. As Paul Hawken puts it in The Next Economy, we are learning to "make the economy more informative by developing methods of production and patterns of consumption that use less energy and capital resources and more knowledge....

The ratio between mass and information is changing and it must continue to change. Our prosperity depends on it" (2).

The information revolution is also a social reality. Section 3 illustrates how information is influencing the opportunities and constraints in finance, government, work, learning, health, crime and justice, the waging of war and the struggle for peace, and many other aspects of our lives. The impacts of information grow exponentially as information permeates every other aspect of society.

We believe that changes now underway in information technology and the role of information in society represent an evolutionary jump in capabilities comparable to the largest similar changes in the past (see Table 1-1). The development of speech in human evolution produced the distinctly human form of intelligence and created culture. The invention of writing, a breakthrough in information transmission and storage, made possible a stage of logical thinking and social organization beyond what could be achieved in oral cultures. It also made written history possible, beginning a pattern of cumulative learning across the ages that was probably irreversible. Printing dramatically accelerated the spread and interaction of ideas, contributing to the Protestant Reformation, the Renaissance, the rise of science, and the emergence of democratic self-government.

Table 1-1: Information Jumps

- Speech
- Writing
- Printing
- Wire, Wireless
- Computer
- Universal Information Access

Source: Institute for Alternative Futures

It ultimately allowed the creation of complex modern social structures such as private corporations and public bureaucracies. Wire and wireless communications made effective economic and political organization possible on a continental scale. Now communications satellites and trans-oceanic fiber optic cables are linking the entire planet far more effectively than ever before. And the computer has produced a greater jump in computational and information processing capabilities than anything since the early development of logic and mathematics.

Our view is that if we can avoid pitfalls, like the misuse of information technology for social control, then current developments have the potential to converge toward what might be called universal information access. It would mean that anyone, anywhere, could instantaneously talk, write, conference, and send visual information to anyone else. It would give us all access to information resources equivalent to the collections of the world's great libraries, and give us tools to radically simplify the task of finding the needles we are looking for in this vast haystack of information. It would ultimately allow us to relate to information more interactively, think more holistically, express ourselves in multiple media, and cooperate effectively with people who share our interests wherever in the world they may live.

Two decades ago the futurist John Platt wrote that "If all our knowledge can be brought together in a familiar system within everyone's reach, the increase in the intelligence and effectiveness of our behavior should be astonishing" (3). This is the promise of universal information access, and why we believe its potential emergence is comparable with other great "information jumps" of the past. This jump could be a defining characteristic of the century ahead and, indeed, of the next millennium: the Information Millennium.

OTHER MAJOR SOCIETAL CHANGES

The information revolution is part of an even larger process of technological change and social transformation. Consider, for example, some of the other technical jumps that have occurred since the beginning of World War II. Molecular biology and recombinant DNA methods may prove as large a jump as the domestication and breeding of plants and animals in terms of impacts on biological evolution. The jump we are beginning to take to high energy efficiency and to one or more of the "eternal" sources of energy - renewables, fusion, fission breeders - is as significant as the jump to fossil fuels. Arthur C. Clarke argues that the first steps into space taken over the past generation will eventually be viewed as one of the great evolutionary developments in history, comparable to life coming out of the ocean and gaining a foothold on the land (4). Automation will eventually provide a productive capacity far beyond all pre-World War II tools. Nuclear weapons are arguably the largest jump in destructive power since the invention of tools and weapons made human beings the dominant species on the planet. Improvements in medical technology have lengthened lifespans and brought the end into sight for many of the great killers of human history such as malaria, tuberculosis, and polio.

These are virtually unprecedented changes, changes by orders of magnitude. Futurist John Platt estimates that during the past century communication speed has increased by a factor of 10^7 , transportation by 10^3 , energy use by 10^3 , disease control by roughly 10^2 , and the destructive power of weapons by 10^9 (5).

Our society is also going through enormous social changes. Changes in women's roles and related changes in men's roles, family size, family structure, patterns of childraising, and attitudes toward sexuality are the

largest cultural shifts in these areas since the beginning of the Christian era. We have begun to understand that we are not outside of nature but part of a seamless ecological web of life. Deep attitude shifts are underway regarding a growing desire for meaningful work. Racial and ethnic discrimination are being delegitimated. Pressures for participation are occurring in every institution, including the modern corporation. And we are beginning to appreciate the magnitude of the many challenges that confront us, the "world problematique" or problem of interrelated problems: the arms race, population growth, food, development, ecology, climate, energy and resources, employment, and much more.

So many large changes, both technological and social, happening simultaneously in a time period of one or two lifetimes, may well be unprecedented in human experience. Kenneth Boulding has observed that "the world today... is as different from the world in which I was born as that world was from Julius Ceasar's. I was born in the middle of human history, to date, roughly. Almost as much has happened since I was born as happened before" (6). Section 4 explores the ideas of social theorists who feel that these changes constitute a transformation of civilization.

While the information revolution is part of a larger pattern of change, it is a pivotal part. The next stage of technical and social evolution cannot be achieved without the information revolution. Other technical jumps, from spaceflight to mapping the human genome, depend on computers and other developments in information technology. Television, xerography, the telephone and other information technologies have played a crucial role in generating high-speed surges of social change of the kind that occurred with the civil rights movement, the ecology movement, the opposition to the war in Vietnam, and the growth of conservatism. Secretary of State George Shultz, in a recent speech on "The Shape, Scope, and Consequences of the Age of

Information," said that the Strategic Defense Initiative (SDI) "can well be described, in fact, as a gigantic information processing system" (7). Whether you find this statement exciting or depressing, it makes a point: information and information technologies are opening new possibilities for virtually every other area of change.

THINKING ABOUT THE FUTURE

The extraordinary scale and speed of change in our society has important implications for strategic planning and for anyone trying to think about the future.

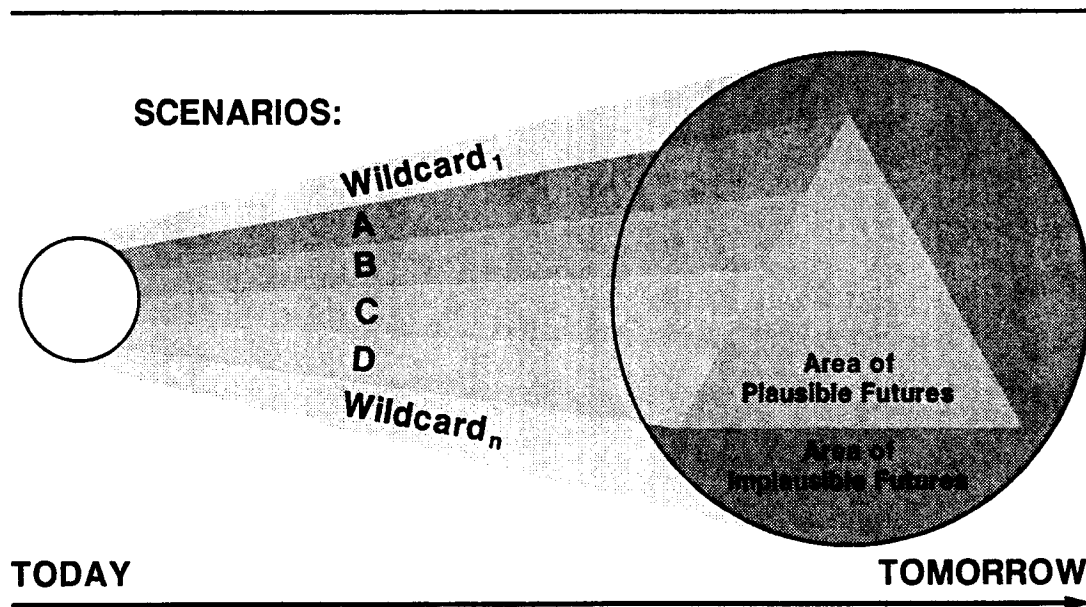
1) **Foresight Is Essential.** The faster change is occurring, the more essential it is to look ahead at where you might end up. The explosive rate of change in the information industry, far surpassing rates of change in most of the economy, means that participants in the information industry must be particularly concerned with thinking more consciously and systematically about the longer-term future as well as the immediate future. No one is immune from the need to demonstrate good period-to-period performance, but optimum long term performance requires a long-term perspective. Taking greater responsibility for the social impacts of the information revolution also requires looking beyond the next few years and into the 21st Century.

2) **There Is No Single, Certain Future.** So many large changes, happening so quickly, and all interacting with each other, mean that predictions cannot be made as confidently as in the past. While we all must make "best guess" assumptions about the most likely future, these assumptions are at best uncertain.

3) Monitor Key Trends. However, the future is not totally unknowable. It is possible to systematically monitor trends and emerging developments in technology, industry and society. Monitoring trends allows management to understand the leading edge of change and develop better means for rapid adaptation to change. However, trends in technology, industry and society are often ambiguous or point in conflicting directions.

4) Think In Terms Of Plausible "Alternative Futures." One powerful approach for coping with the future's inherent ambiguity and uncertainty is to think in terms of a small number of "alternative futures" that envelop or bound a broad range of possible future conditions. Thinking through several scenarios or "alternative futures" can help executives identify uncertainties and clarify unexamined assumptions about "what might be." Scenarios can stimulate the imagination and generate creative options. Scenarios allow decision-makers to explore robust and adaptive strategies that can work across a wide range of future conditions. They can be used to formulate a strategic vision and can provide a common language for communicating that vision throughout a company. Figure 1-2 illustrates the capacity of scenarios to allow decision-makers to envision a broader range of plausible future conditions (the triangle) than a single scenario provides. We develop this approach in Section 6 where we set out four plausible alternative futures for society and the information industry.

Figure 1-2: Focus on Plausible Futures



Source: Institute for Alternative Futures, Copyright IAF used with permission.

Scenarios also allow the parallel consideration of several topics simultaneously. For example, Figure 1-3 illustrates the scenario matrix for this report: four scenarios within which technology applications, society and policy vary.

Figure 1-3: Alternative Futures for the Information Industry

	High-Tech Information Society	The Creative Society	Things Bog Down	1984 and Beyond
Technological Capabilities				
The Industry and Applications				
Societal Implications				
Policy Issues				

Source: Institute for Alternative Futures.

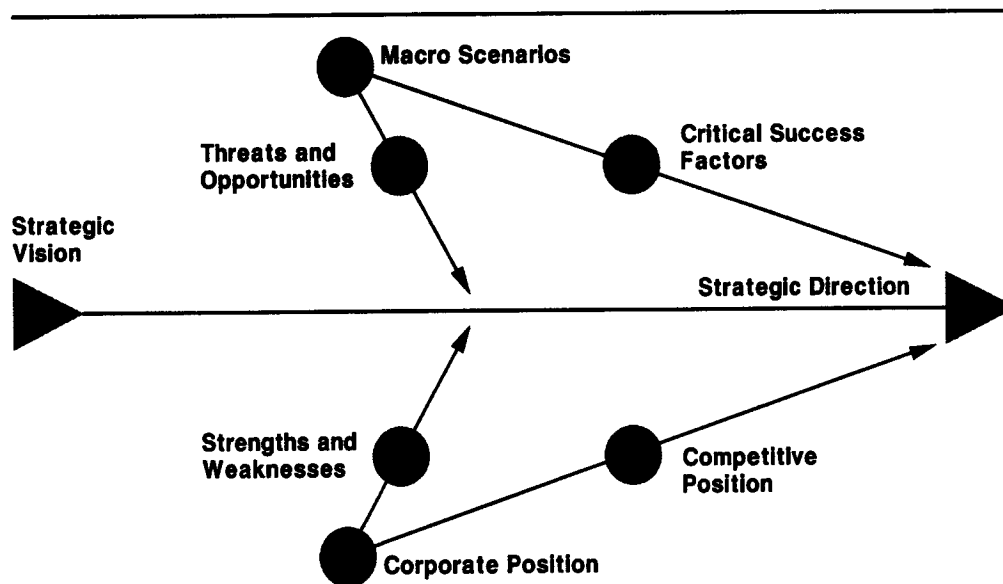
5) Shape The Future: A Strategic Vision Of The Preferred Future. Given a set of plausible scenarios, it is essential to ask what is the preferred future. Within the range of what is plausible, what is the best that can be achieved for our personal lives, our organizations, our industry, and our society. It is in this sense that computer pioneer Alan Kay counsels:

"The best way to predict the future is to invent it." (8)

The preferred future represents our strategic vision - an inspiring statement of what can be accomplished. As Figure 1-4 indicates, creating a strategic vision for an organization involves more than just setting a goal. A powerful strategic vision grows out of the threats and opportunities and critical success factors inherent in the macro scenarios or plausible futures. Strategic vision also incorporates a clear sense of a company's strengths and weaknesses, including its competitive position. The strategic direction for

an organization is based on an assessment of the threats and opportunities posed by the external environment, and the strengths and weakness of its own organization.

Figure 1-4: Strategic Vision



Source: Institute for Alternative Futures, copyright IAF used with permission.

This report, The Information Millennium provides macro scenarios that can assist readers to develop a strategic vision that involves individuals, their companies, the information industry and society. Another way of describing this is to think in terms of the concept of a "Me Tree" which Charles Tower of Dun and Bradstreet suggested as we were preparing this report.

The Me Tree begins with the individual: one's own capabilities, values, goals, and beliefs about what is needed to create a better society. It extends outward to a view of one's company's capabilities and goals, and extends further to a view of how one's industry can best contribute to progress in the nation and the world. Tower suggests that when all these levels are aligned -- when personal goals are being fulfilled through pursuing

enlightened company goals, and when the information industry as a whole has more conscious goals which address the key needs of our nation and the world -- then the power to "invent the future" is maximized.

Integrative "big picture" thinking of this kind obviously cannot be done on a day-to-day, decision-by-decision basis. It is possible, however, to set aside periods of time to look at the big picture and develop a strategic vision for guiding day-to-day decision-making. The message of this report is that a broader strategic framework for decision-making will in the long run produce better products, more profitable companies, and a better society. Appendix 1 contains exercises that allow readers to use the "me tree" concept and the contents of this report to develop their strategic vision.

This insight about the importance of strategic vision, and the importance of the alignment of vision, is perhaps the central insight of current management theory. It is expressed clearly and forcefully in the recent book Leaders: Strategies For Taking Charge by Warren Bennis and Burt Nanus, futurists and business school professors at the University of Southern California:

"Vision animates, inspirits, transforms purpose into action.... When the organization has a clear sense of its purpose, direction, and desired future state and when this image is widely shared, individuals are able to find their own roles both in the organization and in the larger society of which they are a part. This empowers individuals and confers status upon them because they can see themselves as part of a worthwhile enterprise. They gain a sense of importance, as they are transformed from robots blindly following instructions to human beings engaged in a creative and purposeful venture. When individuals feel they can make a difference and that they can improve the society in which they are living through their participation in an organization, then it is much more likely that they will bring vigor and enthusiasm to their tasks and that the results of their work will be mutually reinforcing. Under these conditions, the human energies of the organization are aligned toward a common end, and a major precondition for success has been satisfied" (9).

Our vision, in creating this report, is to stimulate you to more consciously formulate your own vision -- for yourself, your company, the information industry, and society, so that the information revolution can truly prove to be a "boon, not a bane" for mankind.

Notes

1. Michael Roger Ruben and Mary Taylor Huber, The Knowledge Industry in the United States: 1970-1980. This volume updates Fritz Machlup's classic study entitled The Production and Distribution of Knowledge in the United States. The other classic work in this area was done by Marc Uri Porat for the Office of Telecommunications in the U.S. Department of Commerce. Porat argued that the information sector of the labor force has grown from less than 10 percent in 1880 to over 40 percent in 1970 and would grow beyond 50 percent in the 1980's. Marc Porat, The Information Economy: Definitions and Measurement, (Office of Telecommunications Policy, U.S. Department of Commerce, Special Publication 77-12, May 1977).
2. Paul Hawken, The Next Economy (New York: Holt, Rinehart and Winston, 1983), pp.2-4.
3. John R. Platt, "Where Will The Books GO?" in The Step To Man (New York: John Wiley and Sons, 1956), p.17.
4. Arthur C. Clarke, The Promise of Space (Berkeley: Berkeley Books, 1985),
5. These estimates are taken from John Platt's article, "What We Must Do," Perception and Change (Ann Arbor: University of Michigan Press, 1970).
6. Quoted in Alvin Toffler, Future Shock (New York: Bantam Books, 1970), p. 13.
7. Secretary of State George Shultz, "The Shape, Scope, and Consequences of the Age of Information," Current Policy No. 811 (Washington, D.C.: United States Department of State, Bureau of Public Affairs, March 21, 1986), p.1.
8. Alan Kay, "Inventing the Future," The AI Business: Commercial Uses of Artificial Intelligence, eds. Patrick H. Winston and Karen A. Prendergast, (Cambridge, MA: MIT Press, 1984) p.103.
9. Warren Bennis and Burt Nanus, Leaders: The Strategies for Taking Charge (New York: Harper and Row, 1985), pp.30, 90-91.

2. TECHNOLOGICAL CAPABILITIES IN THE YEAR 2000

INTRODUCTION

Imagine what cars would be like if for the past twenty years their performance increased by 20 to 50 percent per year and their size and price for a given level of performance declined at the same rate or even faster. As Norman Augustine, President of Martin Marietta Corporation, puts it, "There would be 2-cent cars measuring a quarter inch on a side, and no parking problems" (1). This is what has been happening with computer processing power, storage and other key areas of information and communication technology. There is nothing else in today's economy that compares with this phenomenal rate of technological progress. Our analysis indicates that this rate of advancement will continue at least through the end of the century.

This section explores future progress in information technology, foreseeable limitations that may come into play, and potential breakthroughs. All estimates focus on the year 2000. That millennial date is only fourteen years away, but in the fast-paced evolution of information technology, fourteen years is a very long time. Detailed forecasts are impossible, and surprises are inevitable. It is possible, however, to forecast general technological capabilities. This section constructs a rough sketch of the general technological capabilities that seem likely by the year 2000. The next section examines applications that advancing technologies can make possible.

In the following discussion of the future of information technology, we focus on "Extrapolative Projections" and examples of "Potential Breakthroughs." Extrapolative projections, or "No-Brainer" projections, identify developments that seem quite likely -- likely enough that we would be

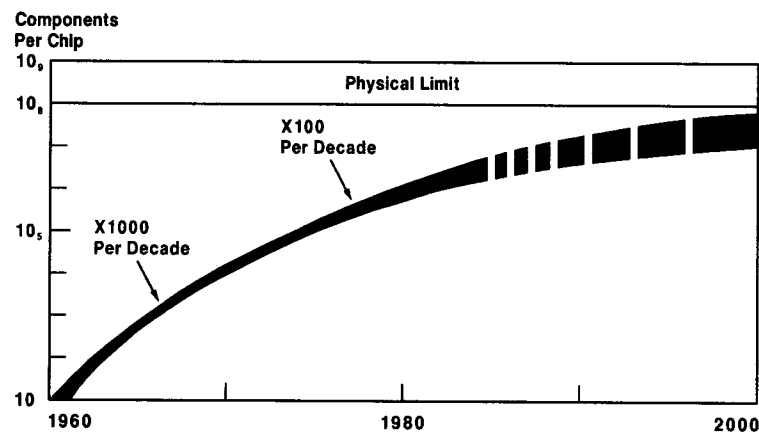
surprised if they did not occur by the year 2000. Potential breakthroughs refer to developments that are possible but less likely. Extrapolative projections and examples of potential breakthroughs are set out in the following areas: microelectronics, computing technology, software, storage, artificial intelligence, telecommunications, input and output devices and systems integration.

MICROELECTRONICS

Extrapolative Projections

The single most important force in the evolution of information technology today is progress in squeezing ever more components on tiny integrated circuit chips (2). The number of transistors and other components that can be packed on a single chip doubled annually between 1972 and 1981 (11,000 in 1972 and 600,000 in 1981). Today, we can pack nearly a million components on a chip about 1 square centimeter in size, and packing density is still increasing by a factor of 100 per decade. Present growth rates would reach at least 5 million components per chip by 1990 and between 10 and 100 million by the year 2000 (see Figure 2-1).

Figure 2-1: Changes in Component Density for Silicon Production, 1960 to 2000



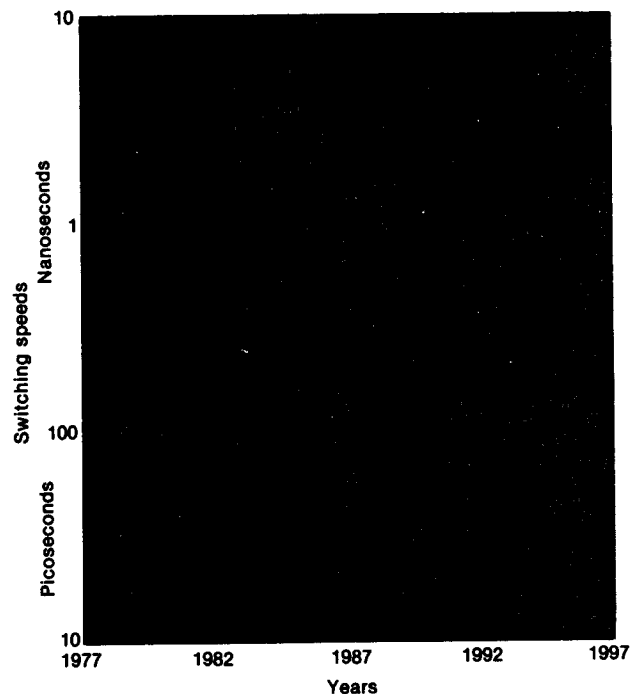
Source: 1960 to 1990 estimate from AT&T Bell Laboratories as cited by John S. Mayo, "The Evolution of Information Technologies", in Information Technologies and Social Transformation, Bruce R. Guile, Ed., National Academy Press: Washington, D.C. 1985, pp.11. Copyright AT&T Bell Laboratories, used with permission. Extrapolation from 1990 to 2000 by IAF based on Dataquest forecast.

Ultimate limits of the technology as we know it today may occur in the region of 100 million components per chip. Ultimate limits are determined by how small the line widths that define a working transistor can be made and by how large a single chip can be made. The estimate of a limit near 100 million components per chip assumes the smallest feasible line widths at 0.1 microns (the new Intel 80386 is a 1.5-micron chip and 1.0 micron prototypes are being produced) and the largest practical chip size at about 1,000 square millimeters (3).

Increasing packing density and decreasing circuit feature size have produced dramatic increases in the speed of integrated circuits. Circuit speed, the time it takes for a circuit to go from on to off or vice versa, crossed the millionth of a second threshold somewhat over 20 years ago, and crossed the billionth of a second threshold by 1977. By 2000, switching speed

is likely to be converging on practical limits in the region of 1 to 10 trillionths of a second (Figure 2-2).

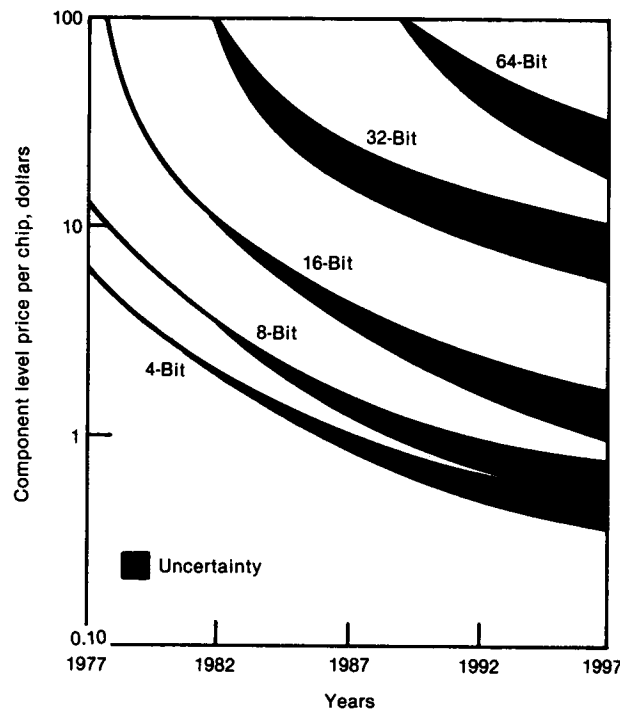
Figure 2-2: Trends in Device Speed - Stage Delay per Gate Circuit



Source: Arthur D. Little, Inc., estimates as cited in Information Technology R&D: Critical Trends and Issues, Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-CIT-268, February 1985, pp. 328.

As density and speed have improved, costs per function have dropped dramatically. Over the past 20 years, the cost of manufacturing integrated circuits has decreased by a factor of 1,000 and costs are still falling rapidly. Figure 2-3 projects the median prices of microprocessors currently in use.

Figure 2-3: Median Microprocessor Price v. Time (1,000 unit purchase)



Source: Arthur D. Little, Inc., estimates as cited in Information Technology R&D: Critical Trends and Issues, Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-CIT-268, February 1985, pp. 325.

In sum, it should be possible to put the circuit complexity of today's large mainframe computers into a single chip computer the size of a book -- or perhaps a credit card -- by the year 2000.

Examples of Potential Breakthroughs in Microelectronics

Neural Networks: A new approach to integrated circuit design, and to computer architecture in general, is based on circuits that partially replicate the way neurons act and interact in the neural networks of the brain. There are ardent proponents of this new approach, sometimes called "connectionists," and also ardent critics, who believe neural network research is a passing fad. While the prospects for neural networks are still unclear,

they could prove to be extremely important - perhaps the most revolutionary information technology development in the remainder of the 20th century.

Waning interest in the concept of "biological computation" was suddenly revived with a vengeance in 1982 when John J. Hopfield, a biochemist with Caltech and Bell Labs, suggested a new, elegant mathematical model for computing with neural circuits. In 1986, researchers at Bell Labs built the first prototype "neuronic" circuit chip with 22 "neurons" and 484 "synapses" or connections, and the system worked exactly as Hopfield's simulations had predicted. Hopfield's model suggests that even simple neural networks have an unexpectedly powerful capacity for solving optimization problems -- problems of the kind that come up in pattern recognition, motor control, and behavioral choice where goals are pursued in the presence of conflicting constraints.

Success in neural network research could lead to significant progress in computerized "hand-eye coordination" for robotics, optical character recognition, and speech recognition and synthesis. Robert Hecht-Nielsen at TRW Inc.'s Rancho Carmel Artificial Intelligence Center believes that by the mid-1990's most computers will be half-serial and half-neural. Major breakthroughs in neural networks might provide a new foundation for the development of artificial intelligence. Already, simple simulations of neural networks display capabilities for learning and self-programming in areas like pronunciation and three dimensional vision (4).

Smaller Line Widths: X-ray lithography will produce a new generation of chips with smaller line widths to be introduced in the early 1990's. But further developments are possible by the year 2000. Electron beam lithography and ion implantation may succeed in reducing line widths to near 0.01 microns, increasing the number of components per chip by a factor of 10 over the extrapolative projection. The shrinking of line widths will encounter

ultimate limits related to quantum mechanical effects that disrupt the flow of electrons in circuits.

3-D Chips: Ion-beam technology might allow the development of 3-D circuits which stack chips into three dimensional structures. Many problems need to be solved to make 3-D chips possible, in particular the problem of connecting elements buried within layers of semiconductor material.

Wafer-Scale Integration: The number of components per chip could be expanded by enlarging the chip itself, which requires progress in the development of pure semiconductor materials and defect-free circuits. Efforts underway today might succeed in increasing chip size by a factor of 10 to 100.

New and Compound Materials: Integrated circuits based on gallium arsenide (GaAs) have significant advantages over silicon devices, including higher speed, lower-power consumption, radiation resistance, and compatibility with lightwave technology. New designs that deposit gallium arsenide on a silicon base may be stronger and cheaper than chips made wholly of gallium arsenide. New chips made of molybdenum and many other compound semiconductor materials are also possible.

Optoelectronics: Combined electronic and photonic circuits could make possible optical computers capable of speeds in the range of trillions of operations per second. The increased use of optic fiber for transmission "pipes" makes optical processing especially attractive. However, major theoretical as well as practical advances will be needed to make optoelectronic devices competitive in size and cost with electronic devices.

All-Optical Transistors: Recent progress in optical switching technology suggests the possibility of creating optical transistors with switching times

as fast as 1 femtosecond, or 1 quadrillionth of a second. Optical circuits may never be as small as electronic circuits, but their speed could make them more powerful. Because light beams do not short-circuit when they cross, optical technology would make it easier to engineer massively parallel architectures (5).

Josephson Junctions: Integrated circuits made from superconducting Josephson junctions could switch and store electronic signals with unparalleled speed and very little power. The operation of Josephson junction technology requires expensive, super cold environments. Problems of cost, packaging, manufacturing, and reliability have slowed research and development, and major companies have backed away from the technology in recent years.

Molecular Electronics: Molecular electronics is the use of man made molecules to replace conventional transistors, logic gates, capacitors, resistors and the other units that make up today's integrated circuit chip. The theoretical capabilities of molecular-scale circuitry are staggering. A 1 - Billion Byte molecular memory computer could be put in a box a micron wide. Molecular scale computers might be implanted in the human body, interfaced with nerve cells, and used to actuate prosthetic limbs, increase memory, enhance vision, hearing and other senses, and speed up human response time to stimuli (6). While this technology is unlikely to unfold by the year 2000, it is a "wild card" that, if and when it appears, would revolutionize every area of technology and human life.

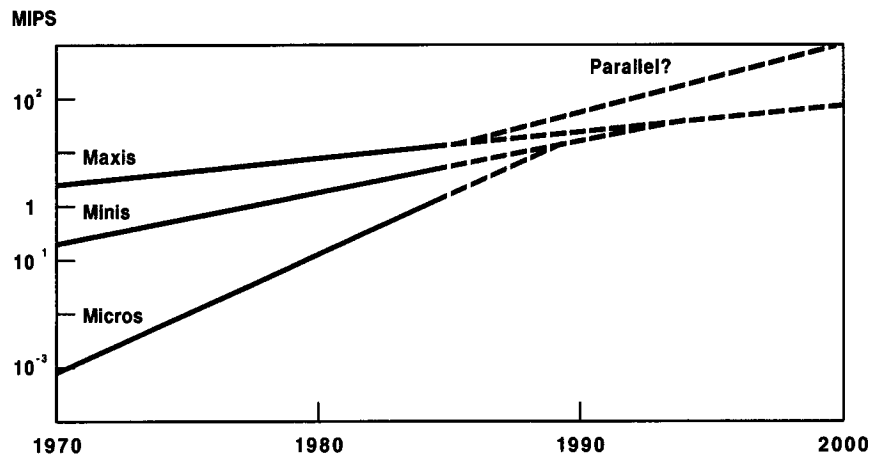
COMPUTER PROCESSING POWER

Extrapolative Projection

Figure 2-4 projects computer processing power expressed in millions of instructions per second or MIPS. The most dramatic aspect of the projection

is the power of single chip microcomputers, which has been doubling every year for over a decade. Extrapolation of this trend to the year 2000 suggests that the distinction between micro, mini, and mainframe computers almost disappears. By 2000, small micros are likely to be at least as powerful as today's large, general-purpose mainframes. Machines based on parallel processing will be the most powerful computers at the end of the century.

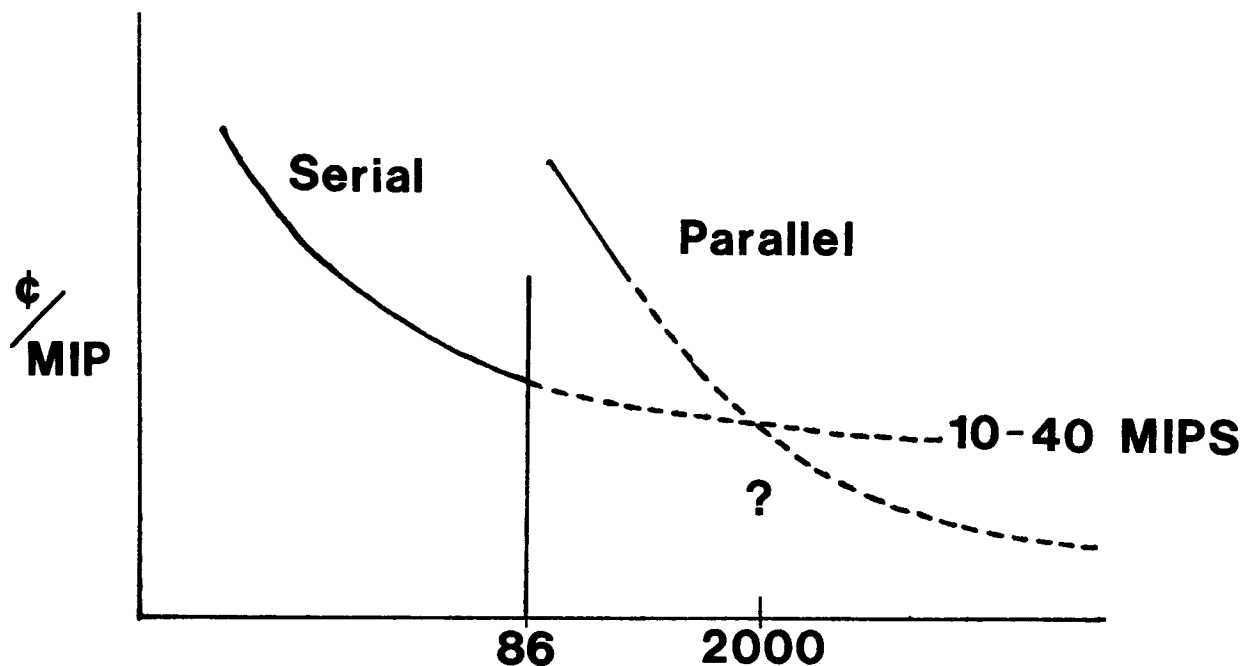
Figure 2-4: Trends in Computer Processing Power, 1970 to 2000.



Source: 1970 to 1990 estimate from AT&T Bell Laboratories as cited by John S. Mayo, "The Evolution of Information Technologies", in Information Technologies and Social Transformation, Bruce R. Guile, Ed., National Academy Press: Washington, D.C. 1985, pp.13; Copyright AT&T Bell Laboratories, used with permission; 1990 - 2000 IAF extrapolation based on Dataquest forecast.

Figure 2-5 extrapolates the cost of computing power, which has been declining by 20 percent per year for mainframes and 50 percent per year for microcomputers. It suggests that as microcomputer power increases to mainframe level, the cost of micros will probably decline or at most remain fairly constant; cost/power will decline spectacularly. The extrapolation also suggests that we will be increasingly surrounded by inexpensive, high-level computer power distributed into our factories, offices, homes, automobiles, appliances, toys, and virtually anywhere it adds to product function (7).

Figure 2-5: Trends in Cost of Processing Power



Source: Dataquest

Near the year 2000, the power of single-chip computers will increase to 10 MIPS or more (8). Single processor computers look like they will reach their limits in the 10 to 40 MIPS range. (By comparison, today's 3M workstation is a 1 MIPS computer and the next generation of PC workstations available by 1988 will be 3 MIPS machines.) For most applications in appliances, tools, automobiles, and the like, 10 to 40 MIPS computer chips should be more than sufficient. This level of power will also support the emergence of high resolution visual and graphic displays, intelligent or "friendly" software to make operation much simpler, and many aspects of artificial intelligence "knowledge processing."

This 10 to 40 MIPS limit on chip processing power is not a limit on the power of computers. Figures 2-4 and 2-5 also project the development of computers with parallel processing architectures. Already, the Thinking Machine Corporation's Connection Machine can execute between one and seven

billion instructions per second in certain simple operations on large amounts of data (although MIPS or BIPS may not be an appropriate measure for the power of parallel computers). Since the early 1950's, nearly all computers have been designed around one basic architecture, which was originally developed by the mathematician John von Neumann. In this "serial" architecture, instructions and data are stored in memory and everything is processed, one by one in sequential fashion, through a single adder/subtractor. Now, new parallel processing architectures using multiple processors and distributed memory systems are being developed for use in massive calculating tasks, such as weather forecasting and modeling aerodynamic flows around three-dimensional objects where the traditional von Neumann architecture is already becoming a bottleneck to computational speed. Unconventional integrated circuit architectures are also being developed for custom applications such as image and graphics processors and symbolic processors for the manipulation of nonnumerical information. Parallelism is likely to be expensive because of the high cost of interconnecting chips and programming them to function as a single computer.

Examples of Potential Breakthroughs in Computer Processing Power

Integrated Circuit Breakthroughs: Any of the breakthroughs in microelectronics discussed above could make it possible to create more powerful single-chip computers. For example, wafer-scale integration might make it possible to design 100 to 400 MIPS chips.

Cheap Chip Interconnection: The expense and difficulty of interconnecting integrated circuit chips to operate as a single computer is what drives today's efforts to pack ever more components on a single monolithic chip. The invention of a cheap, reliable method of chip interconnection would open the way for enormous jumps in computer power and radically new computer

architectures.

New Computer Architectures: We are now seeing structures of parallelism that range from 10 to over 65,000 processors in the Thinking Machine Corporation's "Connection Machine." These systems represent the first explorations into a vast new territory of potential computer architectures. This territory could be radically expanded by other breakthroughs in neural networks and cheap chip interconnection or software design.

New Software Architectures: Software is the key constraint in the development of computers with non-von Neumann architectures. To take advantage of new computer architectures, we need to change our way of thinking about how computing gets done and learn to write programs in new ways. By the early 1990's, we will begin to learn how to do this.

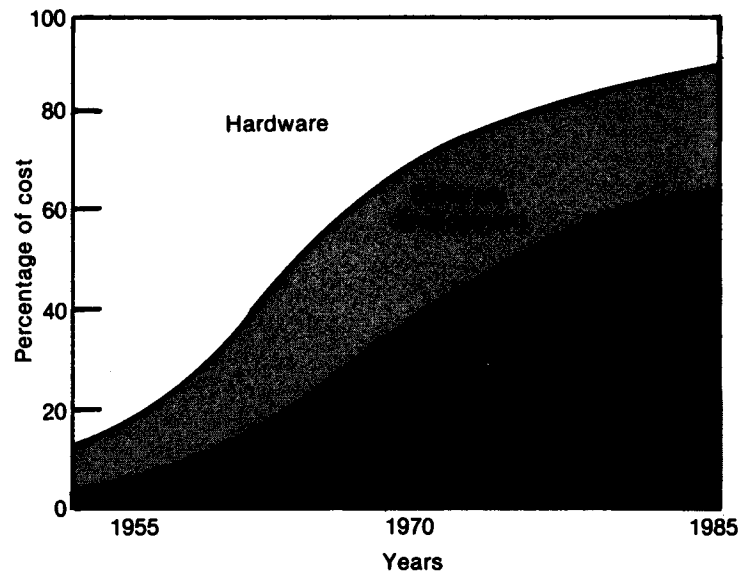
Understanding of Parallelism: Developing the full potential of new hardware and distributed-software architectures requires breakthroughs in the understanding of parallelism. Success in neural network research could be critical for a full understanding of parallelism.

SOFTWARE

Extrapolative Projections

Software is the bottleneck of information technology today. As hardware and computing power become cheaper, the cost of software becomes a higher and higher proportion of the cost of new information systems (see Figure 2-6).

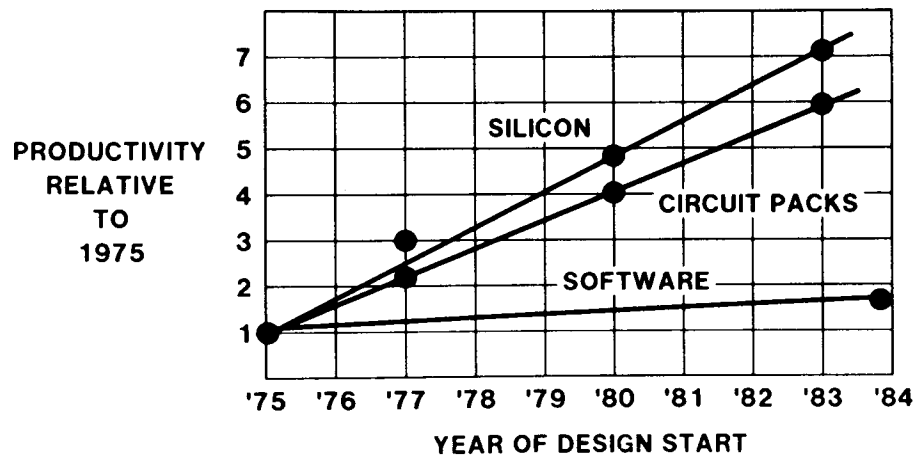
Figure 2-6: The Relative Costs of Software and Hardware



Source: Steve Olson, Pathways of Choice, Mosaic, July/August 1983, as cited in Information Technology R&D: Critical Trends and Issues, Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-CIT-268, February 1985, pp. 332.

Unfortunately, improvements in programming productivity are coming very slowly. Figure 2-7 contrasts the slow productivity growth for producing software with the rapid productivity growth for designing integrated circuit chips.

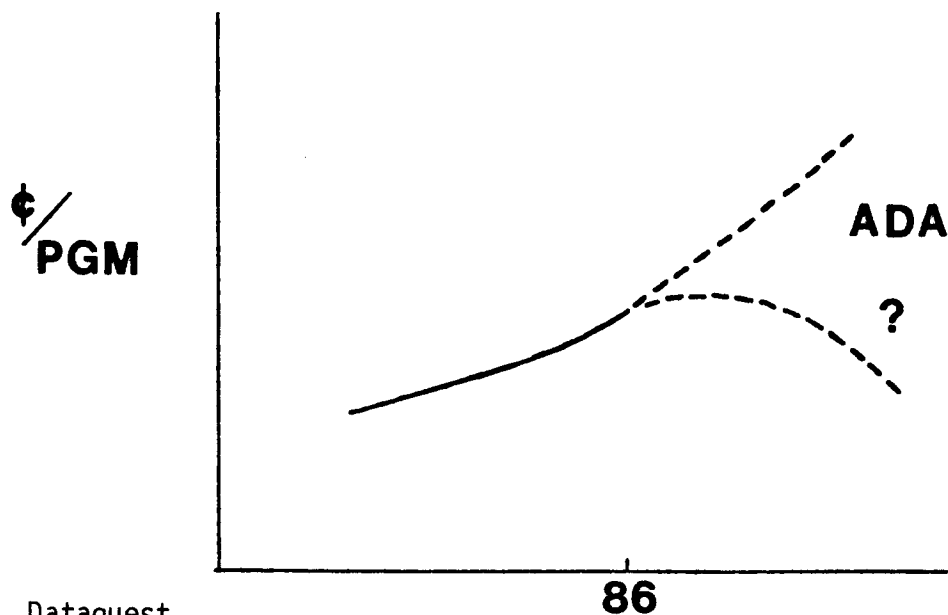
Figure 2-7: Hardware and Software Productivity, 1975 to 1984



Source: AT&T Bell Laboratories as cited by John S. Mayo, "The Evolution of Information Technologies", in Information Technologies and Social Transformation, Bruce R. Guile, Ed., National Academy Press: Washington, D.C. 1985, pp. 14). Copyright AT&T Bell Laboratories, used with permission.

Because of slow productivity growth for producing software, the cost per program of software has actually gone up over the past 30 years. Software is the only aspect of information technology where prices have gone up rather than down (see Figure 2-8).

Figure 2-8: Software Costs



Source: Dataquest

The nature of this software bottleneck is fairly well understood. The problem is that a scientific basis or organizing calculus for software development has not yet been established. As a result, most software development is ad hoc. New programs are typically created from scratch, without drawing systematically on the experience gained in previous programming projects, and without reusing well-tested parts of older programs. It still takes a programmer about a year to generate a few thousand lines of code, and demanding applications like telecommunications switching systems can require one or two million lines. Large programs, created by teams of individuals with different programming "styles," can be virtually incomprehensible to other programmers. Resources for creating new software are limited because roughly 50 percent of data processing budgets are spent on debugging old programs or modifying them because their applications requirements were not specified adequately in the first place. Efforts to introduce new software design tools are often frustrated by uncertainties

about the effectiveness of the tools and by high costs associated with retraining software manpower and converting existing program inventories.

Software productivity would be higher if there was more uniformity in the real world -if each software program could apply to vast numbers of settings. For example, if all employee benefits programs had the same structure, or if all educational systems used the same criteria for measuring success, then a single software program would suffice for different organizations. Industry standard setting groups, such as the ANSI group seeking to standardize business to business transaction protocols, may ease this problem in some settings, but the untidyness of the real world will continue to be a factor in the low productivity of software development.

The path of progress to the year 2000 is less clear for software than for other aspects of information technology. But some progress is likely because the demands for software development are becoming insistent -- for making information systems easier to use or "friendlier;" for allowing people to quickly find the specific information they want in large information bases; for customizing systems to user's needs; for programming massively parallel computers; for knowledge processing in artificial intelligence (AI) systems; and for many other applications. Corporate and public resources are increasingly being directed at breaking the software bottleneck.

By the year 2000, there will be considerable development of reusable standard-function software modules with standardized interfaces. The Department of Defense (DOD) is supporting the development and use of an advanced computer language, Ada, as the single standard programming language for DOD software engineering, so it is likely that Ada will be a prominent programming language in the year 2000. Some progress will be made in developing more rigorous methodologies and new computerized tools for requirements specification, the critical and extremely difficult task of

specifying in detail an information system's objectives and the tasks the end users want performed. There will also be some progress in developing large software design programs for generating, testing, and maintaining other software, and progress in creating programming environments that integrate these design tools (10). Experimentally-based statistical methods for evaluating the effectiveness of software tools will be increasingly applied. And all these changes will be supported by the development of software engineering as a more systematic and well-funded field. There is a reasonable chance that developments like these will increase software productivity enough to put software costs on a declining curve before the year 2000 (see Figure 2-8).

Examples of Potential Breakthroughs in Software

"Program Provers:" Automated formal verification systems verify that programs perform as specified and "debug" faulty programs. Program provers are already employed in advanced software systems, but there is considerable disagreement about how reliable these systems can be made to be. The public controversy over the feasibility of designing reliable software for strategic defense (SDI) battle management systems is one manifestation of this debate about program provers. Fundamental breakthroughs in program theory are needed to make automated program provers widely applicable.

Very-High-Level-Languages: The development of another generation of programming languages beyond Ada might allow software developers to automatically convert specifications explained in abstract, general terms into detailed, machine-executable procedures.

Dramatic Improvements in Computer Aids for Software Design: More dramatic progress than assumed in the extrapolative projection, including powerful

minisupercomputer and AI design tools, could lead to cheaper software development and the automatic generation of applications programs.

A Threshold Effect in Accelerating Software Creation: Rapid progress might occur if software itself improves past a threshold which allows the creation of better design tools for developing software, initiating a positive cycle of accelerating software creation. This kind of accelerating effect occurred on the hardware side when the development of transistors led to better computers which allowed computer modeling of semiconductor circuitry, which led to better computers and better semiconductor design tools.

Knowledge Representation: Research in human cognition and artificial intelligence may provide dramatic advances by developing basic concepts for representing and organizing different kinds of knowledge. Breakthroughs in this work would probably lead to rapid progress in information system requirements specification and in the development of very-high-level-languages.

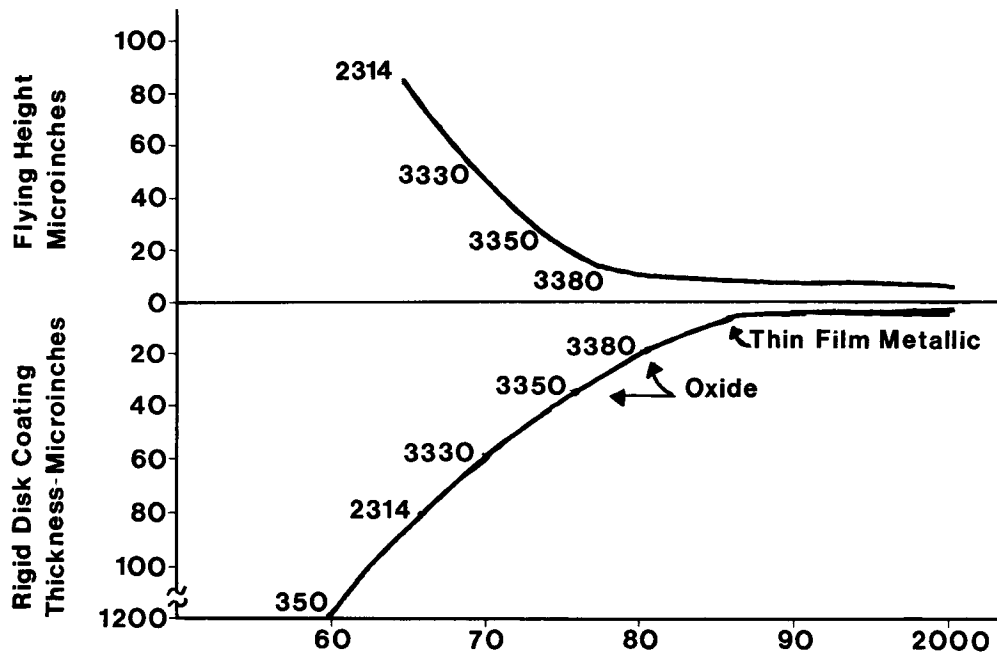
STORAGE

Extrapolative Projection

All forms of technology for storing electronic information are improving rapidly. Random access memory (RAM) chips for computer primary memory are being improved at an even more impressive rate than central processing unit (CPU) chips. A 10-megabyte chip could be only a year away, and 100-megabyte chips are possible by the year 2000. The cost of semiconductor memory has been falling by 35 percent per year.

Secondary memory, where information is not lost when the power is turned off, has been dominated by magnetic technologies in the form of tapes, floppy disks, and hard disks. The "bit density" or amount of information that can be packed on a magnetic disk has increased substantially over time, but this trend may not continue. Figure 2-9 shows that two key parameters determining the density and speed of access of magnetic disks, the thinness of the magnetic layers on the disk and the flying height of the head over the disk, are both approaching their limits. This puts a severe physical limitation on the potential for progress in magnetics and suggests that the bit density of magnetic disks will reach a plateau in the 1990's (11).

Figure 2-9: Magnetic Storage Technology Limiting Factors

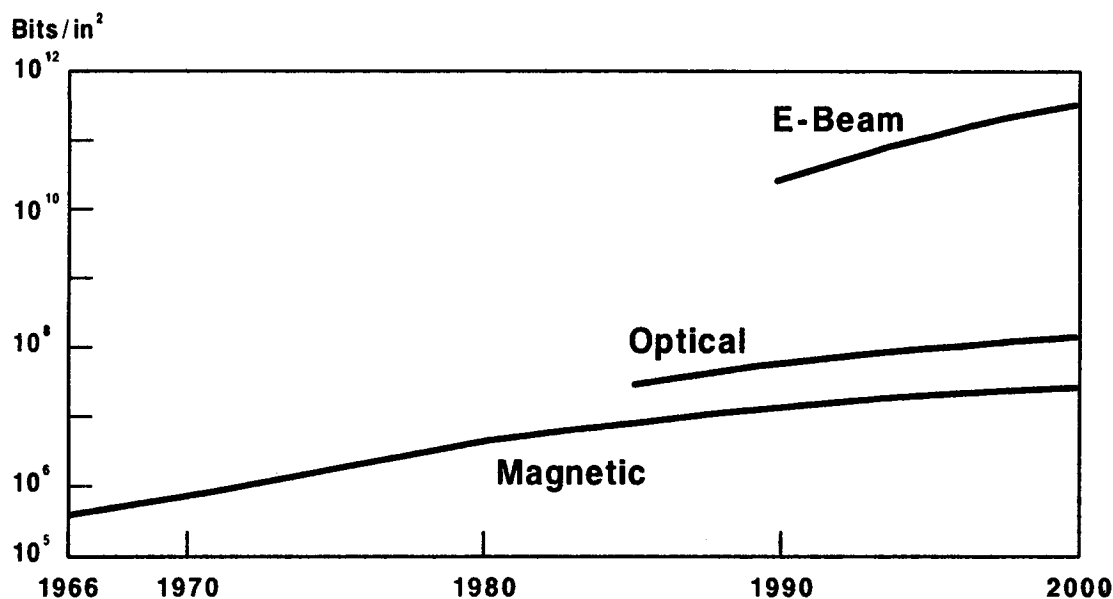


Source: Dataquest

New optical technologies get completely around the density limits on magnetic media. The compact disks (CD) that have revolutionized high fidelity music are about to do the same for information storage. CD-ROM (compact disk read-only memory) and CDI (compact disk interactive) systems currently coming into the marketplace have a storage capacity an order of magnitude beyond the best magnetic technology. The equivalent of 250,000 pages or nearly 1,000 books can be stored on one 4.7-inch-diameter disk. Optical disks can also store color images, animation and full-motion video as well as sound, opening the way for multi-media applications. By the year 2000, the use of data compression and other techniques may be able to reduce CD-ROM storage space to about 15 percent of what it is today. Then a single disk could hold the equivalent of nearly 6,000 books, and roughly 160 of these disks could contain the equivalent of a fully indexed million volume library. Figure 2-10

compares the projected densities of optical vs. magnetic storage. Optical technology is also becoming inexpensive very quickly due to the "Stevie Wonder dynamic": the explosive growth of the audio CD market is creating economies of scale in the manufacture of compact disks and players.

Figure 2-10: Comparing Storage Densities of Magnetic and Optical Disks



Source: Dataquest

Optical disks currently have two serious disadvantages that will be overcome between now and the year 2000. The first is that they are "read-only," which means that users cannot write on the disks or erase them. Within a year or two, however, write-once-read-many (WORM) storage devices will allow users to write but not erase. Writable magneto-optic disks already

exist in prototype but are expensive and too slow for many computer uses. Current research on disks made with new materials arrayed in orderly crystals, that can be melted to erase, may overcome the problems of magneto-optic disks. Through one technical route or another, cheap, erasable optical storage is likely to be available by the year 2000.

The second disadvantage of optical systems is that they are not as fast in retrieving data as conventional magnetic systems. The access time for current CD-ROM devices is 400 to 500 milliseconds compared to about 18 milliseconds for the best magnetic technology. However, it is possible to speed access time substantially through software tricks. There is so much space on an optical disk that every item on the disk can be indexed directly to lower the search time necessary to find any particular piece of information (12).

CD technology may have great impacts on other technologies. For example, erasable optical storage might turn out to be a "killer" technology that replaces magnetic storage in most applications.

Examples of Potential Breakthroughs In Storage

Short-Wavelength Semiconductors: In recording an optical disk, a laser burns spots on the recording substance. Spot size, which determines bit density, is proportional to the wavelength of the lasing light. Thus, development of semiconductor lasers with shorter wavelengths would allow the density of optical disks to go up.

Frequency Domain Optical Storage: The use of a turnable laser, a laser that can be adjusted over a broad range of light frequencies, could permit thousands of separate bits of information to be stored on top of one another at different frequencies. Overlapping bits of data could be accessed

separately by varying the laser frequency. Frequency domain optical storage could potentially increase the capacity of optical disks by a factor of 10 to 1,000.

E-Beam Recording: Recording with electron beams (E-beams) could lead to an order of magnitude increase in bit density over recording with optical lasers (see Figure 2-10). The idea has been around for many years, but the problem has been that as densities go up, error rates go up exponentially. Until recently, the needed error correction schemes have been too expensive, but as semiconductor costs continue to fall, E-beam will deserve a serious look. E-beam could potentially put 50 gigabytes or the equivalent of 90,000 books on a compact disk. Then the 20 million books and pamphlets contained in the Library of Congress could be carried in about 220 of these 50 gigabyte disks.

Magnetic Bubble Memories: Magnetic bubble memories utilize "bubbles" or circular magnetic domains in garnet materials as the storage media. They have been commercially available for over a decade, but presently have slow access times and other disadvantages. Breakthroughs in this technology may still be possible.

ARTIFICIAL INTELLIGENCE

Extrapolative projection

The current high level of interest in AI was stimulated in part by Japan's announcement in 1982 of a 10 year, \$850 million, government-coordinated "fifth generation" computer project to build an intelligent computer. Since then, the DOD's Defense Advanced Research Projects Agency (DARPA) has launched a 5 year, \$600 million Strategic Computing Program to develop robot vehicles, voice-activated computer co-pilots for jet fighters, and battle management systems to help military commanders analyze tactical options. The Microelectronics and Computer Technology Corporation (MCC), a consortium of U.S. corporations, has been established to coordinate private sector resources in an attack on key problems in AI research and other areas of computer technology. Great Britain is pursuing a \$390 million program called the Alvey Directorate, and the Common Market is putting \$1.1 billion into a program known as ESPRIT. Recently, the Soviet Union announced its own 5-year plan to create a "fifth generation" AI computer. Interest in AI is also high because, after 25 years of AI research, the first real AI commercial products have recently begun to enter the marketplace. They include four major categories of products:

- * Expert Systems that attempt to capture the problem-solving knowledge and rules of thumb of demonstrated experts in specialized subjects and aid human experts in making decisions;
- * Sensory Systems such as image or vision processing systems and tactile systems that amplify the capabilities of robots and other automated equipment;

- * Natural Language Processing Systems to allow humans and machines to interact in natural languages such as English, Russian, or Japanese in contrast to a computer language; and
- * Speech Recognition and Voice Synthesis to allow computers to listen and speak (input and output) much as humans do.

What all this national and commercial activity implies for AI capabilities in the future is a matter of great controversy. At one extreme, some AI enthusiasts believe the field is on the verge of an advance that will change the world by the year 2000, revolutionizing everything from education to the global economy. At the other extreme, some critics contend that AI is coming to a dead end because there is no evidence that solutions are in sight to the biggest "bottleneck problems" in AI, such as how to represent "common-sense" understanding in computable form. There is concern in the AI research community itself that exaggerated expectations followed by expensive failures could cast doubt on the entire AI enterprise. AI has gone through several waves of optimism and disappointment in the past as new concepts were developed but then found to be limited when applied to real-world problems. The pattern may be repeating. In Japan itself, enthusiasm for the Fifth Generation Computer Systems Project appears to be abating. The project is far behind in achieving its ambitious goals, its budget has been scaled back, and Japanese companies are increasingly withdrawing their most talented scientists and engineers (13).

An extrapolative "no brainer" approach assumes that recent progress in AI will continue, but does not assume that the large national efforts now underway are likely to produce world-changing breakthroughs. These efforts are attempting to make basic scientific discoveries, which cannot be planned or predicted in advance. They are fundamentally uncertain and risky ventures

compared to the Apollo Program or the Manhattan Project, which were primarily engineering efforts based on already established science.

Significant progress is likely in the areas that have already begun to have commercial impacts. Many more expert systems will be developed. New AI programming languages and computer aids for software design will reduce the costs of building and testing expert systems. Programming that utilizes the mathematical concepts of "fuzzy logic" will help expert systems deal with imprecise data. Microchip-embedded expert systems will operate much faster than conventional systems. However, expert systems are most likely to be used in the limited domains of application where they are most successful today: specialities based on narrow sets of facts and no more than a few thousand rules for making inferences, where decisions can be made by calculative rationality and do not require other mental capabilities such as common sense or holistic understanding.

The widespread use of sensory systems for industrial tasks like robot guidance and control and quality control inspection will be one of the most useful applications of AI technology between now and the year 2000. Massively parallel integrated circuits and more sophisticated algorithms for analyzing visual scenes will improve the performance of computer vision systems, but there will still be limits on their ability to interpret complex and unstructured scenes.

Natural Language Understanding Systems will improve in tandem with increasing computer power and the declining cost of computer memory. They will be used as "front ends" or interfaces to computer systems, data bases, and expert systems. By the year 2000, they will also be used to control some large, complex systems such as weapons systems and power plants. Speech synthesis will be well along, and speech recognition will evolve toward

speaker-independent systems with 5,000 to 15,000 word vocabularies. Natural language systems will continue to be highly "literal" and unable to cope with ambiguity due to the continuing inability to design systems that embody common sense, pragmatic understanding, and broad knowledge of the world. Progress will occur in marrying AI to electronic information systems. By the year 2000, AI will contribute to ease of use in searching databases, reduction of the irrelevant portions of information retrieved, automatically generated searches, and targeted integration of information resources.

Potential Breakthroughs in Artificial Intelligence

Related Information Technology

Breakthroughs in microelectronics, computer hardware and software, and storage could all boost AI capabilities. Success in developing new computer architectures based on parallel processing is especially critical for supporting AI progress.

Neural Networks: The development of circuits that simulate operations of the nervous system, discussed above, could produce breakthroughs in pattern recognition for optical character reading, speech recognition, voice synthesis, and systems capable of interpreting complex and unstructured visual scenes. Neural net research could eventually lead to the deeper understanding of parallelism critical for advancement of AI.

Knowledge Representation: All of the existing schemes of knowledge representation (e.g. production systems, semantic networks, frames, scripts) can only represent "surface knowledge" that is explicitly stated or deductively inferred by chaining propositions. They cannot represent reasoning from facts to general principles, or the common sense knowledge that people acquire through a wide range of life experience, or pragmatic knowledge

about appropriate responses to unique or changing situations, or processes of learning from experience. Breakthroughs in this area of knowledge representation would probably do more than anything else to open the way to true "thinking machines."

TELECOMMUNICATIONS

Extrapolative Projections

Telecommunications refers to the transmission and reception of information by telephone, radio, or other electronic means of communicating over distance. The most spectacular trend in telecommunications technology is the rapid growth of communications capacity. Table 2-1 gives examples of the growing size of the "pipes" for carrying information.

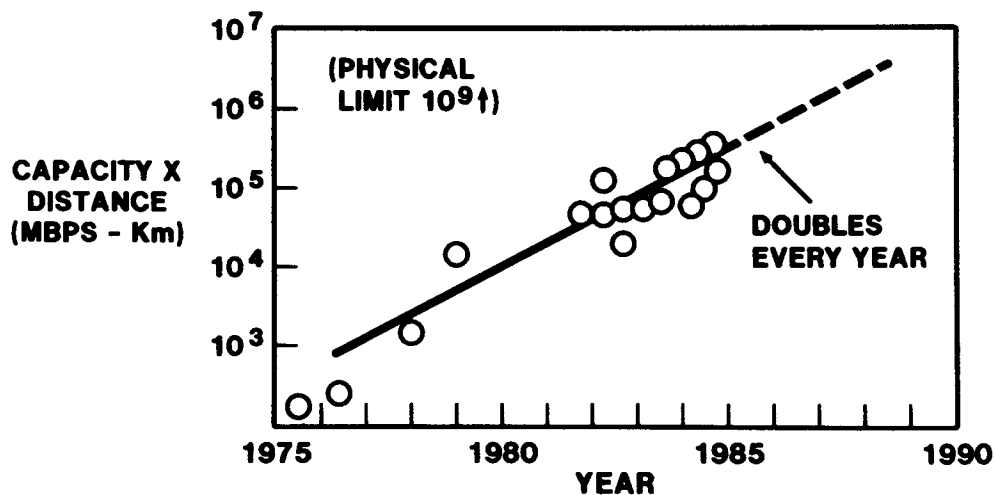
Table 2-1: Increasing Telecommunications Capacity

300 bps (bits per second)	Considered "high speed" data transmission at start of 1980s*
1.2-2.4 kbps (thousands of bits)	Data transmission speed common today*
1.54 mbps (millions of bits)	Very high capacity telephone network lines called T1 carriers**
6 mbps	Capacity of today's satellite transponders**
16 mbps	Extremely clean 4-wire copper circuit under ideal conditions -- not what is actually available*
42-160 mbps	Today's fiber optic technology***
2 gbps (billions of bits)	Rate recently achieved by Bell Laboratories for an 80 mile fiber optic transmission using no amplification****

Source: * Interviews at Dataquest, April 18, 1986.
 ** OTA, Automation of America's Offices, p. 321.
 *** Lawrence Murr, Information Highways, p. 11.
 **** John S. Mayo, "The Evolution of Information Technologies,"
 p. 16.

Fiber optics is the most important new technology for transmitting large amounts of information. It is improving rapidly in terms of both the rate at which information can be sent through fibers and the distance information can travel without amplification. Figure 2-11 shows that the product of rate and distance has been doubling annually for the past decade. It appears fairly likely that this rate of progress can be maintained through the 1980's and 1990's. Improvements in optical fiber are likely because substantial R&D is being devoted to reducing impurities, using different cross sections of fiber cores, using new materials such as plastics, and improving fiber splicing techniques (14). Improvements in optical fiber, combined with the development of higher power laser light generators and more sensitive signal detection technology, could produce lightwave systems 10 to 100 times faster than today's best systems. Progress in wavelength multiplexing could improve performance by another factor of 10 to 100 (15). As Figure 2-11 illustrates, progress at the upper end of these ranges would bring lightwave technology as we know it today within sight of estimated physical limits.

Figure 2-11: Progress of Lightwave Technology



Source: AT&T Bell Laboratories as cited by John S. Mayo, "The Evolution of Information Technologies", in Information Technologies and Social Transformation, Bruce R. Guile, Ed., National Academy Press: Washington, D.C. 1985, pp.18. Copyright AT&T Bell Laboratories, used with permission.

One of the biggest telecommunications projects to the end of the century will be creating optical "information superhighways" that run through major urban corridors, from coast to coast, and span the Atlantic and Pacific oceans. Fiber optics will also find increasingly widespread application in the interoffice trunks that connect telephone central offices, in local feeder lines, and in local area networks.

By the year 2000, fiber optics will be the dominant transmission medium for most fixed applications, and fiber transmission into homes will be beginning (16). The challenge of bringing optical systems across the infamous "last mile" right into homes and offices will not be met fully by the year 2000 except by large corporations or in facilities constructed during the later 1990's. Such delay will only be temporary, however. As Robert Spinard, director of systems technology at Xerox, puts it, "The optics boom is just starting to explode. Optics in the 21st century will be what electronics

represents in the 20th century" (17).

Another great telecommunications project will be virtually completed by the end of the century: making the switched telephone network end-to-end digital and standardized. The telephone network was designed as an analog-based system which transforms the human voice into continuously oscillating electrical wave forms, unlike digital signals, which are represented by discrete, discontinuous pulses. The shift underway to digital connectivity has great advantages. Transmission lines will be able to carry more information more accurately. Organizations will no longer have to maintain separate networks for voice and digital data communication. People will be able to talk to people, as usual, but they will also be able to send visual images and to communicate with computers (and computers will be able to talk to each other).

Complex patterns of technology competition and change will unfold between now and the year 2000. For example, the spread of optic fiber will be limited by existing investments in copper wire and cable that still have to be amortized. Satellite traffic capacity is expected to increase by an order of magnitude (See Table 2-2). But cable will compete with satellites, and in the 1990's, optical fiber economies may cause displacement of satellite transmission. Another example of communications technology competition will occur in office automation, where the competition between private branch exchanges (PBX's) and local area networks (LAN's) for providing high speed data communication between office machines will probably lead to hybrid networks employing both PBX and LAN architectures. Another example is the rapid advancement of cellular radio technology. Today, it is producing a rapid proliferation of vehicle-mounted radiotelephones, but during the 1990's, improvements in cellular technology will make most of those vehicle-mounted

phones obsolete as hand-held portables decline in price to around \$300 per unit (18). These complex and unpredictable patterns of technology competition highlight the importance that information content-oriented companies should give to a strategy of media-independence.

Table 2-2: Growth in Satellite Capacity
(Equivalent Standard 40-MHz Transponders)

<u>Year</u>	<u>World</u>	<u>U.S.</u>
1980	426	156
1985	1,410	478
1990	3,100	756
1995	5,580	1,135
2000	9,870	1,655

Source: IEEE Communications, May 1984.

Examples of Potential Breakthroughs in Telecommunications

Optical Switching: Optical switching is the bottleneck in optical communications systems. Current switching costs make it impractical to bring fiber optics across the "last mile" into most buildings. Multiple conversions from light to electronic also slow down the transmission rate of optical communication. Breakthroughs in the development of less expensive, faster, more reliable switches would bring the vast capacity of fiber optics to the whole spectrum of telecommunications applications. Major progress in optical-switch technology is just now beginning to be reported from research labs at GTE and Xerox and from Japan, Sweden and Scotland (19).

Cellular Cost Performance: High-capacity, spread-spectrum cellular technology could conceivably increase in cost performance to the point where portable cellular telephones start to replace conventional phones. Cellular systems are theoretically capable of serving all residences within a metropolitan area, and they can be used for data applications as well as for voice. The

more the cost of cellular systems goes down, the more new applications would be possible.

INPUT AND OUTPUT DEVICES

Extrapolative Forecast

The importance of the keyboard as the dominant data entry device will be reduced between now and the year 2000. Optical character recognition (OCR) performance is improving so rapidly that it is likely to produce a significant reduction in the volume of manual data entry before the end of the century. By 2000, OCR readers will probably be able to read virtually all standard typed and printed fonts and hand-print, but they may still have a limited capability to read individualized, connected handwriting (20). The marriage of OCR with facsimile will create new potentials for communicating written material and inputting documents into future integrated office systems (21). Speech recognition input technology (SR) will also provide an alternative to keyboard data entry, although it will develop much more slowly than OCR. Most commercial SR technology today can only recognize a small vocabulary of words spoken clearly, with a pause between them, by a single individual for whom the device has been programmed. By the year 2000, application-specific or task-oriented SR systems with vocabularies of several thousand words and the ability to recognize continuous speech from many speakers will probably be available.

Unlimited vocabulary, general-purpose SR will probably not be possible until well into the 21st Century. But if SR can be improved to as little as 10,000 to 15,000 words of continuous speech, it can be used to automate functions such as accepting commands to the computer, accepting customer's orders over a telephone, and dictating rough drafts of documents (22).

Display technology will evolve toward higher-resolution, large-screen,

bit-mapped displays. This trend is already well underway: the bit-mapped cathode ray tube (CRT) on the early Apple Macintosh displays about 180,000 pixels or picture elements while the next generation workstations will have roughly a million pixels (23). Flat screen displays that can be hung like a picture or carried in portable devices will increasingly dominate display technology, going from roughly a 5 percent market penetration in 1986, to 15-20 percent in 1990 and 30-35 percent by 2000 (24). Substantial progress is likely because a variety of flat panel technologies are being developed (See Table 2-3). Today's prices are largely determined by the cost of electronics and the cost of manufacturing mistakes, so there is room for improvement (25).

Table 2-3: Flat Panel Price Trends

Projected Average Selling Price Per Character
Based on 2,000-character display
(includes drivers and controllers)

	1984	1985	1989
CRT-COLOR	\$0.15	\$0.15	\$0.11
CRT-MONOCROME	\$0.06	\$0.06	\$0.05
ELECTROLUMINESCENT	\$0.40	\$0.32	\$0.18
ELECTROPHORETIC	N/A	N/A	\$0.12
FLAT CRT	\$0.10	\$0.09	\$0.07
LCD-ACTIVE	\$2.00	\$0.85	\$0.20
LCD-MULTI	\$0.25	\$0.15	\$0.06
PLASMA	\$0.50	\$0.44	\$0.27
VFD	N/A	\$0.50	\$0.24

Source: Dataquest

Printing technology will also evolve rapidly. The trend towards networking and the use of shared printing resources will put a priority on high performance. The trend away from text-based to graphics-based computing, where typefaces and sizes of type can be changed at will and graphic images

can be merged into text, will produce a surging market for corporate electronic publishing (25). Both of these trends will tend to favor the development and use of non-impact printing technology over the more traditional impact printing technology.

SYSTEMS INTEGRATION

Systems integration will be a key driver of information technology evolution. The great challenge ahead is total interconnectivity and interoperability, the vision of "universal information access" that can give any user any kind of voice, data or image service in any combination at any place. Systems integration will move us much closer to this goal by the year 2000.

System integration is ultimately a technological challenge. Already the main wire, wireless, and fiber optic communications networks are highly interconnected. The development of a fully digital telephone system by 2000 will effectively merge telecommunications and computer technologies. The creation of a stable systems software base (an operating system) will allow software developers and computer users to move gracefully to successive generations of more powerful computers that are all interoperable.

However, systems integration is also a "political" process of standards development. For example, by the year 2000 a still-evolving but universally recognized open systems interconnector (OSI) model will provide standards that all telecommunications technologies can converge to, so that almost any system in the world will potentially be able to communicate with any other.

By the year 2000, an integrated service digital network (ISDN) with services such as digitized voice, facsimile and graphics, video, videotex, software and data transfer, electronic mail, data base access, word processing, teleconferencing and computer conferencing, and teleprinting will

have come into place in many parts of the world. ISDN planning may well be the most comprehensive attempt at international technical cooperation in human history.

Some think residential ISDN use will still be minimal in the year 2000 due to expense and lack of demand, but business applications will be widespread. Others feel that technologies such as those used in Pacific Telesis' Project Victoria (which turns one residential phone line into two voice channels, two data channels, and a slower signaling channel) and enhanced network capacities on the part of the Regional Bell Operating Companies will mean that residential ISDN may be common by the turn of the century.

SUMMARY

Table 2-4 summarizes the extrapolative forecasts for technological capacities in the year 2000. In reflecting upon these forecasts, it becomes evident that conservative projections combine to form a picture of prodigious technological capabilities likely to be in place by the end of the century. Moreover, if only a few of the potential breakthroughs we identify should be achieved by the year 2000, it could make a large difference in technical capability.

Table 2-4: Summary: Technology 2000

- 10 - 100 Million Components/Chip, Contrasted To Nearly 1 Million Today
- 10 - 40 MIPS Micros, compared to 1-3 MIPS today
- Parallel Architectures
- 3 Gigabytes on a Read-Write-Erase CD
- Fiber Optic Capacity Increased 10 to 100 Times Beyond Today
- End-to-End Digital Phone System
- Extensive Expert Systems
- High OCR Performance
- SR With 5 - 15,000 Words Continuous Speech
- Good Speech Synthesis
- High Resolution, Bit-Mapped, Flat Screen Displays
- High Performance Non-Impact Printing
- Many Potential Breakthroughs
- Price Declines On Most Technologies of 5-35%/Year

Source: IAF

The information revolution is indeed a technological reality. What we can do with these emerging capabilities is the subject of the next section.

Notes

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2. John S. Mayo, "The Evolution of Information Technologies," Information Technologies and Social Transformation, ed. Bruce R. Guile (Washington, D.C.: National Academy Press, 1985) pp. 11-12.
3. Ibid.
4. For a definitive description of neural network theory, see John J. Hopfield and David W. Tank, "Computing With Neural Circuits: A Model," Science, August 8, 1986, pp. 625-633. For popularized, non-mathematic descriptions, see Erik Larson, "Neural Chips," Omni, (November 1986), pp. 113ff; and Curt Supplee, "Is This A Thinking Machine, Or Not?" The Washington Post, October 5, 1986, pp. C3. The example of the functioning of the eye is from Dataquest. April 8, 1986 meeting of Vice Presidents and Group Directors at Dataquest, a company of the Dun And Bradstreet Corporation, 1290 Ridder Park Drive, San Jose, California 95131. Organized by Ralph Finley, Executive Vice President, for the IIA project on the Information Business of the Future.
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6. K. Eric Drexler, Engines of Creation (New York: Anchor Press, Doubleday, 1986), p.19.
7. Dataquest, op.cit.
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10. Information Technology R&D: Critical Trends and Issues, Office of Technology and Assessment, U.S. Congress. OTA-CIT-268 (Washington, D.C: Government Printing Office, February, 1985) pp.75-87.
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14. OTA, op.cit. p.73
15. Mayo, op.cit.
16. Future Information Technology - Telecommunications, Department of Commerce, NBS 500-119 (Washington, D.C.: U.S. Government Printing Office, 1984).
17. Steven Koepp, "And Now, the Age of Light," Time, October 6, 1986, p. 56.

18. Ibid., at p. 51.
19. Dataquest, op.cit.
20. Department of Commerce, op.cit p.95-97.
21. Ibid., at p. 102.
22. OTA, op.cit., at p. 316.
23. John P. Crecine, "The Next Generation of Personal Computers." Science, (February, 1986) p. 942.
24. Dataquest, op.cit.
25. Ibid.
26. Barbara Buell, "Now the Print Shop is Just a Few Keystrokes Away", Business Week, March 17, 1986, 106-108.

3. THE INFORMATION MARKETPLACE AND APPLICATIONS

Section 2 describes a potentially revolutionary set of information technologies. How might those technologies be applied by the year 2000? This section reviews the difficulty of making forecasts for information applications and then bites the bullet and identifies possible state-of-the-art applications. The information industry itself will be the major player in producing these applications. The second half of this section provides a summary of the "information industry megatrends" that are shaping its growth.

THE HAZARDS OF FORECASTING INFORMATION APPLICATIONS

In developing this report, particularly in our interviews with experts within the information industry, we were struck by the relative absence of compelling images of how the technologies described in Section 2 could be applied. We also found throughout the industry a recognition that they must become more application or consumer-need driven rather than technology driven.

In addition, we encountered reasoned skepticism about past overblown forecasts for the information revolution. Videotext is the latest example in a series of overestimations of how popular or effective the applications of a technology would be. Other examples include bubble memory devices, Josephson Junction technology, video teleconferencing, some early electronic mail and messaging applications, videodisk, and to a certain extent, PC's for home use.

The information industry is not alone in a sometimes inappropriate optimism about its new product development. A study of 90 market forecasts developed between 1960 and 1980 noted that more than half of these failed. The successful ones stressed market factors rather than historical product precedents or technological possibilities. Among the accurate forecasts of information technologies were personal computers, cordless telephones,

electronic banking, VCR's, calculators, and overnight package delivery. The authors of the study argue that in order to increase the accuracy of such forecasts, it is necessary to: check assumptions about the external environment; use a range of possibilities and probabilities; ask simple fundamental questions (e.g., who is the customer); watch out for euphoria and consumers who may have moved on (e.g., CB radios); don't be dazzled by technology; and stay flexible to enter and leave a market quickly (1).

While detailed forecasts are beyond the scope of this report, we have kept these guidelines in mind in developing a list of what we think will be state-of-the-art applications for the year 2000. In Section 6 we focus on how widely they will be distributed in offices and homes.

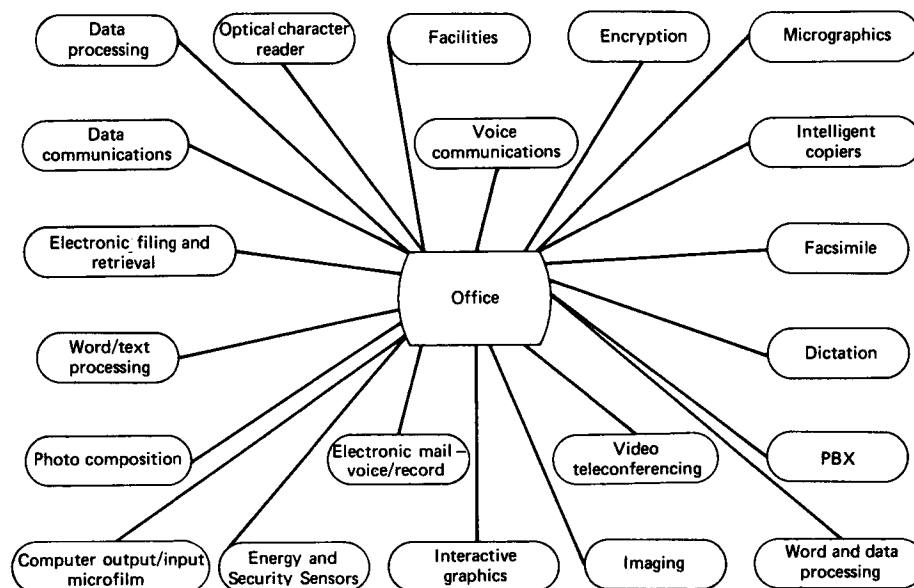
PRODUCTIVE SECTOR/BUSINESS APPLICATIONS

We are using the optimistic assumption that information services and products provided to the business sector will grow at a rate twice that of the GNP because of their continuing enhancements of office productivity. We will focus primarily on office work, though the applications presented here are likely to have counterparts in most aspects of service and retail trade activities, and in office and information functions in manufacturing.

Figure 3-1 identifies the various information technologies that are linked in office automation. Table 3-1 summarizes the potential for productivity enhancements from these information technologies at various levels within a corporation, from CEO to clerk; it considers productivity enhancement in performing four basic information functions: creation, processing, dissemination and retention. Table 3-1 suggests that productivity enhancements will have increasing potential as you work down from the CEO, with the highest potential for professional, para-professional, technical, management secretary, administrative assistants and office workers.

We would argue that while the productivity enhancements at the lower levels identified in Table 3-1 are likely, at the higher levels there may be more room for improvement than Table 3-1 suggests, particularly in the use of expert systems and simulations to aid in decision-making, to generate new insights, to monitor potential implications of decisions for society, and for performance evaluation.

Figure 3-1: Technical Components of Office Automation



Source: Mark A. Lieberman, Gad J. Selig and John J. Walsh, Office Automation: A Manager's Guide for Improved Productivity, (New York: John Wiley & Sons, 1982,) p. 12. Copyright (c) 1982, John Wiley & Sons, used with permission.

Expert systems will accelerate automation in the information industry. LINK Resources has developed Table 3-2 to show AI applications in the life cycle of a database. The potential enhancements are significant. This is not to say that AI or expert systems applications might not have profoundly negative consequences (see the "1984 and Beyond" scenario in Section 6).

Table 3-1: Potential for Productivity Enhancement from Office Automation

	Overall		Creation	Processing(Change)		Distribution (Dissemination)		Retention (Search, Retrieval, Disposal)	
Job Type	Potential	Potential	Function	Potential	Function	Potential	Function	Potential	Function
Chief executive officer (CEO)	Low	Low	Speeches	Low	_____	Low	_____	Low	_____
Vice President (V-P)	Modest	Low	Reports Correspondence Decisions	Moderate	_____	Modest	_____	Modest	_____
Upper management (General manager and director)	Moderate	Moderate	Reports Schedules Correspondence Decisions	Moderate	Productivity data Cost data Budgets Forecasts/ Plans What-if analysis	Moderate	Reports Strategy Plans Orders	Good	Data Various documents
Middle management (Director and manager)	Good	Moderate	Reports Orders Decisions	Good	Productivity data Budgets Costs Status Reports Correspondence What-if's	Good	Reports Orders	Good	Data Various documents
Professional Paraprofessional Technical	High	Good	Reports	Good	Various Data	High	Reports	High	Documents
Executive secretary	Moderate	Good	Schedules Reports Correspondence Telephone	Moderate	Schedules Correspondence Mail Telephones	Good	Various	Moderate	Documents Reports
Management secretary (general manager and director)	High	Good	Schedules Reports Correspondence Telephone Dictation	High	Schedules Budets Correspondence Reports Mail Telephone	Good	Various	High	Reports Data
Administrative secretary (Director and manager)	High	Good	Dictation	High	Reports	High	Various	High	Documents Reports
Office worker	High	Good	Reports	Good	Data Reports	Good	Various	High	Files
Clerk/typist	Good	Good	Dictation Handwritten reports	Good	Various	Good	Various	Low	Files

Source: Mark A. Lieberman, Gad J. Selig and John J. Walsh, Office Automation, (New York: John Wiley & Sons, 1982,) pp. 132-134. Copyright (c) 1982, John Wiley & Sons, used with permission.

Simply put, expert systems will allow the information objectives of databases to be accomplished more rapidly for less money, and will probably generate whole new types of demand.

The history of the data processing field over the last 30 years shows that users often find new and unforeseen applications of technology. For example, the developers of Visicalc thought they were developing a tool for structuring and checking historical accounting. A principal use of Visicalc and subsequent spreadsheets, however, and what put many microcomputers on executives' desks, was creating "what-if" forecasts. While the remainder of this section identifies applications currently being considered, many others are likely to be invented. Some applications, such as electronic mail (E-Mail), may need a special product/opportunity mix. For example, E-Mail could pick up in the 1990's as the architecture of computers makes them more utility-like -- allowing users to send and receive messages without a cumbersome process, or it could grow if local phone companies facilitate consumer acquisition and use of appropriate telephone equipment, as in France, and/or if vendors and advertisers subsidize the development and operation of the system to lower their transaction costs or increase their market.

Or consider the intersection of forces creating the "smart building". The construction and real estate industries are among those converging with the information industry. The breakup of AT&T and deregulation of the telecommunications industry has generated real ferment among office landlords and builders. Some in the real estate field forecast that office building owners will become primary information vendors and systems integrators.

Figure 3-2: AI Applications in the Information Life Cycle

Life Cycle Point	Application	Relevant AI Technology
Creation/Collection/Editing		
Creation/ Authoring	Optical Character Recognition (OCR)	Pattern Recognition
	Inhouse Morgues, Indexing and Abstracting of Text	Natural Language-Text Understanding
	Database Generation	Knowledge Bases and Fifth Generation Databases
Collection	Data Filtering	Object-Oriented Programming Database Generation
Editing/ Organizing	Abstracting and Indexing Passive SDI (Selective Dissemination of Information) Forecasts Language Translation	Natural Language Understanding, Knowledge Bases, Semantic Networks, Frames Symbolic Processing Techniques Translation Technology
Value-Added Applications		
Analysis Selection	Advisory Systems	Rule-Based Systems, Frame-Based Expert Systems
	Active SDI, Automatic Monitoring and Alerting	Natural Language Understanding Techniques
Distribution		
Access/Retrieval	Access across Multiple Databases & Documents Access Assistance Systems	Expert Systems, Knowledge-based Systems, Knowledge Gateways
	English Language Interfaces Intuitive Interfaces	Natural Language Understanding, Graphics, Icons, Mice, Windows, Speech Recognition Bit-mapped displays
Presentation	On-demand publishing	Expert Systems, Intelligent Adaptive Interfaces
	Print Quality/Fidelity to Source	Bit mapped Displays, Windows, Knowledge Bases
	Integrated Presentation Environment	Expert Systems, Graphics, Natural Language Understanding

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Michael Clevenger, with the Real Estate Division of Xerox, argues that "this convergence of the real estate industry with the communications industry will rival, if not exceed, the impact of the interstate highway system on the

hotel, motel, shopping center, suburban residential real estate, and recreation industries" (2).

Interior designer Piero Patri adds that the "smart" building will be the rule - not the exception - by the turn of the century because increases in productivity from information technologies will lead to their being built into new buildings and retrofitted into existing major buildings (3). Others feel that the slow growth of the shared-office-services field indicates that the smart building movement will not take off rapidly.

New products will enhance various applications. For example, Rahul Srivastava, of TRW Systems, argues that geographic information systems (GIS) technology will provide the largest window into any applications that address the question 'Where?' Major applications that require indexing by geography include urban planning, commercial marketing, real estate and retailing. GIS technologies will allow convenient translation between map data and data in tables with zip code or other geographic marking.

The following are state-of-the-art applications available to businesses in the year 2000. The scenarios in Section 6 will consider how widely distributed these technologies are by that time.

Office Information Technology and Applications

- * Automation of most routine office processing at all levels of the organization (see Table 3-1).
- * Sophisticated simulations that can be used for training (all levels of the organization) and for some decision-making.
 - The worker training system of 1995-2000 will include excellent computer simulations and much more effective input/output devices. It will stress practice in all variations of situations (4).
- * Self-learning expert software systems that correct or improve their functioning based on experience (if appropriate breakthroughs in neural networks occur).

- * "Agents," or pre-instructed expert systems which search virtually all information sources according to the user's interests and provide the results in whatever formats are most effective (5).
- * "Hypertext," or text linked in many directions, providing multiple layered levels of detailed information that can be accessed according to the level of knowledge of the user, and their learning style (6).
- * Speech recognition/speech synthesis will revolutionize input/output and be used for correspondence, dictation of documents, computer data entry, keeping minutes of meetings, accepting customer's orders, complaints and inquiries.
- * Language translation assistance that is accurate, rapid and inexpensive. This, along with the communications and marketplace changes described in Section 2 and below in this Section, lead to more efficient global business.
- * "Dynabook", or similar very powerful workstations, facilitate location-independent-work.
- * Creative thinking software enhances business innovation.
- * Optical character and image readers that are very effective and inexpensive.

Databases

- * Single stop information shopping is used by many; either through a personal "agent" or through a gateway service that makes the searching decisions for the user.
- * Real time, market research information, providing next day results on a wide range of purchases, e.g., food, entertainment, equipment; linking credit card use with a wide variety of other information; aided by improvements in point-of-purchase systems.
- * High quality clipping services which search and abstract or provide full text for local automated printing.
- * CD-ROM, and other storage devices allow local full text search and indexing of key internal and external information.

Electronic Transaction System

- * Utility-like equipment eases business and consumer use of electronic systems.
- * Many consumer and business-to-business transactions are electronic and instantaneous. Office to office links aided greatly by early standards setting.

RESIDENTIAL MARKETS/APPLICATIONS

How will households be served by information products? Arlene Fleming and Robert November of LINK Resources summarized the home-use information, entertainment and transaction technologies in 1984 for the Congressional Office of Technology Assessment. The figures in the list below are taken from that report and refer to 1984 unless otherwise noted. The figures for 1986 are taken from the LINK Resources 1986 annual consumer survey, conducted in the first half of that year (7).

- * Newspapers had 63 million daily circulation to 75 percent of all households; 76 percent of adults read at least one newspaper a day.
- * Magazines had a circulation of 305 million monthly.
- * 21 percent of adults read books on a daily basis; 298 million trade books were printed annually.
- * There were 84 million television sets -- 99 percent of households have at least one; the average viewership per day for adults was 3 and 1/4 hours, and over 7 hours for the household as a whole. In 1986, 90.7 percent of households had at least one color TV and 44.6 had one or more remote control TV's.
- * 83 million telephones were installed as of 1984; the average household makes 120 calls a month, just under 4 per day.
- * Cable television was in 34 million homes. 42 percent of households with TV's subscribed to a basic cable service. In 1986 the figure had risen to 49.7 percent.
- * VCR's were installed in an estimated 25 percent of households in 1985. In 1986 the figure was 40.1 percent.
- * There were 84 million radios, covering 99 percent of households with an average of 5.5 radios per household. The average adult listens 3 hours and 12 minutes per day.
- * 62 percent of American households had some form of audio, hi-fi systems in 1984. In 1986 38.6 percent had head-set audio units.
- * Videogame systems occurred in 20 million or 24 percent of households in 1984, by 1986 this was up to 24.8 percent
- * Direct mail included, in 1983, 43 billion pieces of direct mail. In July of 1984 the average household received 18 direct response mailings.

- * Over 11 million home computers were installed in U.S. households in 1984, 20 percent of which have modems, allowing 2.3 million homes access to electronic services. Between 1984 and 1986 the percent of households with PC's had grown from 10 to 14 percent.

How will households use information products and services in the year 2000? Fleming and November provided their own forecast for the next 20 years in the OTA report, arguing that on the surface there will be relatively little change (8):

In the next twenty years we expect more households and smaller family units. The typical household will continue to rely upon broadcast TV and radio and newspapers and magazines for news and information; upon television - broadcast, cable, pay cable, pay-per-view, and upon video cassettes as principal entertainment. It will use the telephone for information as the use of audiotext increases. Direct response advertising will continue to increase to serve the needs of working families for convenient shopping at home - aided by the ease of toll free "800" number ordering and credit card use. In 1983, direct response advertising hit \$11.8 billion -- 14 percent of the media total. A recent study shows it accounts for 27 percent of consumer buying (with retail stores accounting for the other 73 percent). By 1996 thirty-six percent of the households are expected to have communicating PC's enabling advertisers to use this tool to solicit orders augmenting the virtual 100 percent penetration of telephone, television, and radio, 75 percent penetration of newspapers, and 94 percent of magazines.

The information revolution around the house could go in several directions. The discussion of technologies above suggests that it is likely that given the combination of a healthy growing economy, equally growing consumer expenditures on information/entertainment/communications, participation by advertisers and vendors in funding the new media, and ever better price/performance ratios across technologies, the "smart house" of the year 2000 can be expected to have the following:

- * Extensive computing power, (memories of 1 to 2 megabytes) in several devices around the house;
- * Smart telephone system attached to a fully digitized network;
- * Home information center (whether in phone system or not) that facilitates transaction-based services (home banking, shopping, reservation services, investments, etc.) and information retrieval;
- * Dedicated microprocessors that run "smart appliances," eg. the refrigerator, air conditioner and heating system, water heater, washer and dryer. These are more forgiving, energy and water efficient, and run during off-peak hours for better economy. The most important of these are connected by a "home bus" to the home information center;
- * At least one home microcomputer with the power of a mainframe of the mid 1980's;
- * One or more microprocessors of significant power in the entertainment equipment, e.g., in the CDI player and in other audio equipment and video equipment;
- * Controlling, linking computer (either in phone system, stand-alone computer, or entertainment system).
- * Massive, inexpensive storage, say 5 gigabytes of storage in CD-ROM or successor technology.
- * Expert systems of great power and broad application, operating through these various computers.
- * Biomedical/wellness monitoring equipment.
- * Input/output devices which include reliable, inexpensive print and voice capability.
- * In all, 30-40 computers in the home, most as part of appliances.

What will this typical household do with these technologies? The list of potential applications generated by this information revolution include the following:

Family Management

- * Home security
 - * Fire, burglary, storm damage
 - * The most advanced homes in the first part of the 21st Century, if not by the year 2000, would have the counterpart to "Fred the House" described by Alvin Toffler in The Third Wave (9):

Imagine... you're at work, the phone rings. It's Fred, your house. While monitoring the morning news reports for stories of recent burglaries, Fred picked up a weather bulletin warning of a pending heavy rain. This jogged Fred's bubble memories to run a routine roof maintenance check. A potential leak was found. Before calling you, Fred phoned Slim for advice. Slim is a ranchstyle home down the block... Fred and Slim often shared data banks and each knew they were programmed with an effective search technique for identifying household services.... You've learned to trust Fred's judgment, and approve the repairs. The rest is rather straight forward, Fred calls the roofer.

- * Energy management
 - * Climate control
 - * Air freshness assurance
 - * Off-peak power use
- * Home repair instructions
- * Auto maintenance and repair instructions
- * Time management for each family member; family calendar
- * Money management
- * Investment management
- * Personal business/home business management
- * Health monitoring, diagnosis and treatment
- * Child monitoring
 - * The holographic mobile which flutters above the infants crib is driven by the expert system written by one of the country's leading pediatricians. It is guided by the sensing devices in and around the crib which determine the infant's state. The images produced by the holographic mobile are the most appropriate mixture of color, shape and movement for the infant at that particular moment, given his or her state of development, and need for sleep or entertainment (10).
- * Shopping
 - * grocery shopping - home expert systems automatically link tastes, health conditions (including genetic makeup in relation to metabolism), budget considerations within an ordering system that places an order with the local grocery store on a regular basis.

* Education

- * self-directed education for children
- * ever-patient special education expert systems
- * massive home storage of information for hobbies, interests
- * massive home storage and expert systems applied to professional subjects in the home
- * adult education, sophisticated life-long learning
- * "edutainment," entertaining forms of school topics and adult education.

* Life planning and growth

- * value based simulation games
- * life choice simulations, e.g., marriage, children, occupations

* Community resources directories

- * Community bulletin board for the special interests of each family member
- * Video equipment that include extensive video libraries of existing movies and which allow making your own sophisticated home movies.

The applications may be mundane extensions of activities already performed. Or they may be totally new capabilities wherein the new information technologies interact with new forms of knowledge or behavior. Take, for example, the way in which the home health information system is likely to operate in many houses in the year 2000:

The family monitors each family member in a variety of non-invasive ways, developing each one's biochemically unique profile. The genetic sequence contained in the person's DNA, (and the corresponding likelihood of susceptibility to minor or serious diseases), reactions to previous illness, current prime health behavior (diet, exercise, stress, etc.), and occupational risks are all compiled. This information is related to the home information system's copy of the latest in bio-medical knowledge.

This summary of biomedical knowledge, including diagnostic and treatment protocols is supplied to the family and updated quarterly by the family's physician.

(Many physicians in the year 2000 do this because of the shift in incentives. By the mid-1990's up to 50 percent of the insured population in the U.S. got their health care on a "capitated" basis. They paid their doctor or HMO a set amount each year. Physicians moved with the market and recognized the need to keep their patients healthy and doing as much effective self-care at home as possible. Most physicians are part of large health care companies. The resulting patient volume within the company drastically lowers the unit cost of the medical information technologies.) The treatment protocols interact with the persons' genetic data as well as past treatment experience to search for increased susceptibility to the side effects of any medication or other treatment under consideration.

Recognizing that our human frailties have not disappeared, and that each of us learns in different ways, the family's home health expert system advisor is able to act as an effective coach in helping each family member optimize their health, by varying the advice and style of presentation. This has not eliminated free will, or all disease, but it has helped to make most families significantly healthier by the year 2000.

But not to rest on their laurels the family has also found community uses of their medical information systems. They regularly provide a summary of their information in a manner that insures their individual confidentiality to the local consumer group bulletin board. This allows the local consumer group to develop periodic ratings of the local physicians and other health care providers, as well as the treatments used. Massive national aggregation of these local experiences significantly advances our state of biomedical knowledge and allows national consumer groups and employers monitor the quality of care nationwide and in local communities (11).

The details of this image may vary. For example, the summary of medical knowledge may be accessed via the network rather than stored at home, depending on the state of the local network, the nature of storage technologies, health care company choices, etc. The point, however, is that the technologies of the information revolution will interact with other advances in science and technology and with marketplace forces to provide wholly new capabilities. This is as likely in education, recreation, and government as it is in health care.

By the year 2000, the communication capacity of the typical household will be impressive. The fully digitized system in most homes will allow voice and data communication. A variety of advances are likely in upgrading the physical network to the ISDN standard. The result is likely to be the basic ISDN services at close to the current local phone service costs; while transaction and other more advanced services will be close to long distance pricing. As noted in Section 2, Pacific Telesis, in its Project Victoria, is now experimenting with the technologies that allow the normal single "twisted pair" wires in the home to become two voice grade lines, two data transmission lines, and a slow speed signaling line. This type of technology or an equivalent will greatly enhance the in-place telecommunication capacity, probably with low installation costs (many homes will not require additional local telephone company installer visits).

This enhanced capacity will facilitate and be facilitated by transactions from the home. Currently, the average household spends about \$1,000 per year on information, communication, and entertainment in the home. About \$700 or \$800 more is spent per household by advertisers. The spread of electronic transactions from the home will require revenues from advertisers and those organizations which stand to benefit from electronic transactions, e.g. banks, mail order houses, etc. Given this support, by the year 2000 there are likely to be extensive transactions taking place from the home, such as banking, consumer purchases, travel and entertainment reservations and several other consumer/social services (driver's license renewal, income or property tax registration and payment, library card renewal, license plate/tag purchase - this is the "end of the lines" aspect of the information revolution).

One of the information industry megatrends discussed later in this section is the competition between on-site capacity vs network capacity for storage and intelligence. CD-ROM and successor technologies will give homes

great storage capabilities. However, dramatically upgraded phone networks could mean that large databases remain at central locations, along with the powerful expert systems to make the greatest use of them. Thus, in the health example above, the physician's office or the health care company headquarters might store the information and diagnostic protocols for access from the home. Likewise, the providers of local and national networks will make choices in the years ahead that will affect how much flexibility the household users have in adjusting the system to need their needs.

The resulting intelligent networks suggest major changes for the information industry. Private line service for business data use will no longer require dedicated circuits with discrete physical pathways. Instead, software-defined networks will offer "virtual" private lines with full period circuit capabilities but no predefined pathway, much as with packet switching. Your telephone number will follow you wherever you are in the U.S. and most parts of the globe.

The information industry will play a major role in sorting out these options. How is the information industry changing?

THE INFORMATION INDUSTRY

In preparing this report we learned that the information industry can be a difficult entity to define, largely because the industry itself is undergoing significant changes. Appendix 3 presents a variety of data on the size and nature of the information industry, describing it as a \$1.6 billion provider of data, largely electronic; a \$2.3 billion "electronic publishing industry"; an \$11 billion "media industry"; and a \$15 billion "information vending industry". Within the Information Industry Association the definition has broadened so that now the information industry includes "those companies

that are involved in the generation, packaging and/or distribution of information"(12). This is the definition we use in this report.

Information Industry Megatrends

The major forces shaping the industry can be summarized as a set of "megatrends" which are now present or emerging. Our choice of these information industry megatrends has been influenced by a large number of people, but particularly Chris Burns, Haines Gaffner, John Jenkins, Joseph Laird, Harvey Poppel, Steven Sieck, Michael Tyler, Frederick Zieber and Paul Zurkowski (13).

1. Globalization of the information marketplace is likely as worldwide standards and the lowering of barriers to free-trade evolve by the year 2000.
2. Convergence of information/communication vendors will intensify over the next fifteen years as distinctions blur between products and services, content and facilities, information and entertainment, and the audio, video and data modes. Vertical integration and industry consolidation will continue from mergers and buyouts, and as companies enter new areas of competition.
3. A Tougher competitive environment for companies in the information industry is emerging because of the entrance by large companies from other sectors of the communications field, and by new small companies. At the same time, the dollar volume is not growing as fast as anticipated and some of the new media and applications such as videotex have been failures. There are more companies chasing fewer dollars than anticipated. Even in niche markets, which will continue to be very important, it will be more necessary to ensure control of original sources or uniqueness of service.
4. Marketing and distribution channels will be a key to success, favoring larger, established companies and further reinforcing the vertical integration of the industry. The value of many of the new applications will need to be demonstrated. Just as direct field force or telemarketing contact was critical in the success of the largest information industry services, eg. Quotron, Telerate, Lexis, and Dialog, so it will be for other products or services in the years ahead.
5. The Business/Productive sector dominance in the growth of the information industry is virtually assured for the next 15 years. Currently, the business/productive sector use of the information industry's products and services is 10 to 20 times that of the household sector (depending on whose measure is used). And business sector expenditures will grow about twice as fast as those of the

household sector, assuming increasing productivity for information products and services and no major shifts on the home front.

6. Advertiser/transaction revenues from vendors are required for growth of information services in the home. The information share of the household budget is likely to remain relatively constant. In addition to relatively low monthly fees from consumers, various forms of advertising subsidies and revenues from companies selling products via electronic transactions will be necessary for home information systems and services to significantly expand.
7. Ever better and cheaper technology will become available between now the year 2000. As noted in Section 2 above, information and communications technologies will continue to become smaller, smarter, faster, cheaper, more powerful and easier to use.
8. Desktop power will be aided by the new storage media such as CD-ROM, expert systems, enhanced graphics and communications capacity. The number of desks from which information is sought will grow significantly from a base of only 1 million of the six million desk-top computers in 1985 (14). By the year 2000 the "desktop power," of the prime business user will have further decentralized to wherever the office worker wants to make use of their "dynabook," wristwatch computer, or telephone system-based information utility.
9. Network vs. On-Site Capacity will determine how widely penetrated the most advanced technologies are. It is likely that an enriched network capacity stimulated by aggressive regional telephone companies and their competitors could make significant information storage and intelligence capacities available to most offices and many homes. Alternatively, the development of very cheap mass storage, expert systems and new ways of financing information generation (see copyright discussion in Section 5 below) could mean that every office, library and many homes have very large amounts of stored information on-site.
10. While the interoperability of communication/information equipment is not guaranteed, it is likely that all major business equipment and much home equipment will be able to communicate with virtually all other equipment in voice and data modes.
11. Utility-like equipment is likely for the major technologies; they will be as easy to use as the telephone, many will be voice actuated. This will greatly enhance the penetration of more advanced information functions into business settings. This utility-like nature of the equipment will be produced both by more effective hardware, but even more importantly by expert systems software which greatly simplifies the use of most information applications.
12. Information content grows in importance over facilities as those facilities (particularly storage, computing power and communications capacity) rise in effectiveness and decrease in cost. Effective software, database and support services will gain in relative importance.

13. **Disintermediation** will accelerate. Disintermediation, a concept popularized by Paul Hawken in his book The Next Economy, means that changing technology, markets and consumer competence will eliminate much of the need for middle-men, including many of the functions performed by tellers, telephone operators, teachers, investment brokers, and aspects of MIS/EDP "gatekeepers".
14. **Discontinuous change** is likely. These megatrends suggest a uniform set of forces. However, change is likely to vary significantly in its speed and pervasiveness depending on the particular combination of new technologies, regulatory and policy decisions, social trends and other marketplace forces involved. Reversals, false starts, and dramatic take-offs and sustained expansion will all occur.

In the context of these megatrends and the forecasts of Charles Jonscher, Joseph Laird and Michael Tyler, we will take as a basic, optimistic forecast for the industry, a growth rate of its products and services in the business sector of twice the growth rate of the GNP (15). For the household sector the basic forecast is that information expenditures will grow at about the same rate as the GNP (absent other major factors, information will not be a larger percentage of the family budget in the year 2000) (16). There are potential countertrends that would diminish this forecast (17). The above forecasts, for applications, the industry megatrends, and the countertrends are used in the four scenarios in Section 6.

Notes

1. C. Berenson and S. Schnaars, "Growth Market Forecasting Revisited," California Management Review, (Summer 1986).
2. Michael Clevenger, "Smart Office Buildings," Technology and the Futures of the U.S. Construction Industry, Congress of the United States, Office of Technology Assessment, Proceedings of the Panel on Technical Change and the U.S. Building Construction Industry, (Washington, DC: The AIA Press).
3. Piero Patri, "Smart Office Buildings," Technology and the Futures of the U.S. Construction Industry, Congress of the United States Office of Technology Assessment, Proceedings of the Panel on Technical Change and the U.S. Building Construction Industry, (Washington, DC: The AIA Press).
4. Theodore J. Gordon, "Computers and Business," Information Technologies and Social Transformation. Bruce R. Guile, ed. (Washington, DC: National Academy Press), 1985, p. 158.
5. Alan Kay, "Computer Software," Scientific American. Vol. 251, No. 3 (September 1984), pp. 58.
6. Eric Drexler, Engines of Creation: Challenges and Choices of the Last Technological Revolution, (New York: Doubleday, 1986), pp. 220-226. Hypertext, with its massive storage, would not only allow access to virtually all documents, but also to comment or review on those documents. This full blown version is beyond the year 2000, but for selected libraries and offices it will be applied to massive amounts of information.

Eric Drexler credits Theodore Nelson as the originator of the hypertext idea in his books Computer Lib/Dream Machines (1974) and Literary Machines (1981). Drexler provides an imaginative description of how hypertext might work and how it would be integrated with molecular electronics or nanotechnology: "a book sized object will be able to hold a hypertext system containing images of every page in every book in the world, stored in fast, molecular tape memory."
7. Arlene Fleming and Robert S. November, Impact of Technology on Home Information, Entertainment and Transactions. Prepared by LINK for the Office of Technology Assessment, U.S. Congress, April 1985, and Home Media Survey, (New York: LINK Resources, 1986).
8. Ibid.
9. Alvin Toffler, The Third Wave (New York: William Morrow, 1980), p. 188. Presenting Alan Hald's image of the smart house.
10. Clement Bezold, "Home Computers and Telecommunications in the Future Environments of Children," a Report by the Institute for Alternative Futures for the Foundation for Child Development, May 1980.

11. see Clement Bezold, Jonathan Peck and Rick Carlson, The Future of Work and Health, (Dover, MA: Auburn House, 1986); and Alternative Futures for Health Care, Alternative Futures Associates, Alexandria, VA, 1986.
12. Information Industry Association, The Business of Information 1983, as cited in Paine Webber Mitchell Hutchins Inc., The Information Industry: A first Quantitative Analysis Prepared With the Cooperation of the Information Industry Association, (New York: Paine Webber Mitchell Hutchins, Inc., March 12, 1984), p. 3.
13. The megatrend themes were developed by Chris Burns in "The Economics of Information," Haines Gaffner in his presentation on industry megatrends to the IIA's Boca Raton conference in February of 1986; Joseph Laird in Innovation in Information (New York: Hambrecht & Quist, 1986); Harvey Poppel at the IIA's Boca Raton conference in February of 1986; Steven Sieck in Electronic Information Industry Forecast: 1984-1989 LINK Resources Electronic Information Program; Michael Tyler in "Electronic Publishing, Productivity and the Economic Prospect," Electronic Publishing Plus, forthcoming; Frederick Zieber, "High Tech: An Economic Perspective," Presentation to Dataquest Presidents' Summit Conference, Port Ludlow, Washington, August 20, 1986; Paul Zurkowski in his presentation "An Historical Context for the Information Industry: Its Role in Wealth Generation" to the IIA's Boca Raton conference in March of 1986. See Appendix 3 for affiliations.
14. Joseph E. Laird, op.cit., p. 3.
15. Charles Jonscher, "Information Resources and Economic Productivity," Information Economics and Policy, No. 1, (North-Holland, 1983), pp. 20, 26, 27. Joseph Laird, op. cit. and Michael Tyler, op.cit.
16. Michael Tyler, op.cit.
17. While the above forecasts and megatrends are an appropriate starting place, there are some possible countertrends that could have significant impact on the information industry.

Information systems could become so good that their dollar volume declines as data becomes more accessible and less expensive. Likewise, expert systems could improve to the point where more can be modeled more effectively, actually using smaller samples or key data because of better understanding of the decision-environment. Similarly, as the wisdom of human users of information grows, and as more effective storage takes place in the massive portable storage media we call brains, higher quality information may be sought but sought less often.

The forecasts for growth of the information industry presume their continued productivity increases. Fifteen years of such continued productivity increases could lessen the need for information "raw materials". Or the cost for the information could diminish significantly. Or the productivity increases could have displaced enough jobs that in the absence of any major societal adjustments, consumer spending power declines to the point where the economy is seriously hampered.

Alternatively the home use of information services could increase dramatically with the right combination of technology and consumer demand. For example a much greater interest in using information services might evolve if learning and information related creativity became more prevasive.

4. SOCIETAL IMPACTS OF THE INFORMATION REVOLUTION

Barring catastrophe, the Third Millennium just fourteen years away will be an information millennium - an era where information will be the key strategic resource upon which individuals, organizations and nations rely for their growth and development. Our choices between now and the end of the century could have an enormous influence on the information revolution and the nature of the coming information millennium.

The information industry will play a major role in shaping the information millennium. For example, many in the industry feel that the responsibility for addressing the privacy impacts of new information products and services rests first with the industry. We believe that this kind of thinking -- taking responsibility for the impacts of the information revolution -- is necessary to ensure that its full potential is achieved (and to avoid the dangers described in the 1984 and Beyond Scenario).

In this section we review the potential societal impacts of the information revolution. We look first at its impacts in specific areas, particularly education and employment. Then we look at different whole-system images of how the information society may evolve. The overarching theme is that we are responsible for the outcomes.

SPECIFIC SOCIETAL IMPACTS

What are some of the specific societal impacts of the information revolution that we have already experienced or may experience between now and the year 2000? Future Survey editor Michael Marien constantly scans a wide body of literature. Table 4-1 presents an abridged version of Marien's summary of the impacts of new information technologies.

Table 4-1: 80 Impacts of New Information Technologies

I. International Relations	III. Government
1. Increased rich-poor gap between nations 2. Power leaking out of sovereign nation-states 3. Threat to cultural autonomy in Third World 4. Aid to Third World development 5. Computerized language translation by year 2000 enabling better international understanding 6. Undermining of industrial society interests in USSR 7. Destabilizing military balance of power by possible false alerts, etc.	18. New decision-making models available 19. More information makes decision-making more difficult 20. Tax collection facilitated 21. Increased advantage to incumbent Congressmen 22. Potential to enhance democratic participation 23. Widespread TV changes presentation of politics and intensifies system fragmentation 24. New technologies undermine rationale for airwave regulation 25. Urban planning facilitated 26. VCR use evades government censors
II. Economics and Finance	IV. Crime and Justice
8. New meaning of poverty, wealth, and growth 9. Productivity gains from computers; better models for business decisions 10. Computer enables large-scale trans-national corporations and reinforces existing power distribution 11. Computer enables lower inventories for manufacturers 12. Loss of industry boundary lines 13. Financial deregulation encouraged 14. Home banking encourages use of more services 15. Stock trading globalized and accelerated 16. Increased vulnerability of international financial system 17. Consumers have increased choices available	27. Computer crime more extensive than bank robbery 28. Better surveillance technologies 29. National computerized criminal history system 30. Computerized files interconnected 31. Fingerprint computers for foolproof ID 32. Smart cards for better ID 33. Electronic devices to monitor parolees
	V. Health and Health Care
	34. Telemedicine enabling patient examination at a distance 35. Computers to prepare patient-specific educational materials 36. Computers to assist in diagnosis and cost analysis

Table 4-1: 80 Impacts of New Information Technologies continued

- | | |
|---|---|
| 37. Smart card health records carry full medical history | 60. Mapmaking greatly improved, and computerized maps soon in automobiles |
| 38. Home computer health adviser | 61. Knowledge engineering demystifies expertise |
| 39. "Hospital on the Wrist" to administer drugs and monitor | 62. Databases and electronic publishing link users with authors and publishers without librarians or other intermediaries |
| 40. Technostress | 63. Computerized photo composites may create dangerous deceptions |
| 41. High occupational illness in the computer industry | 64. Blind faith encouraged in computer decisions |

VI. Work

- | | |
|--|--|
| 42. Job displacement | 65. Fragmentation of knowledge as information increases |
| 43. Job creation | 66. Continuous modification of electronic record makes referencing more ambiguous |
| 44. Computer monitoring of employees | 67. "Meaning lag"--growing gap |
| 45. Increased capability of central managers | 68. More uncertainty created |
| 46. Middle managers: shrinking ranks and changing roles | 69. Certain types of knowledge valued less; quantitative criteria more important for decisions |
| 47. Decentralization of operations | 70. Electronic pollution to too many signals creates false readings on instruments |
| 48. Women's work more tedious and specialized | 71. Erosion of copyright control |
| 49. Work at home enabled by computer | |
| 50. Better marketing information for farmers | |
| 51. "Gods and Clods": work divided into smart jobs and dumb jobs | |

VII. Education

- | | |
|--|--|
| 52. New literacy required; need for educated and flexible workforce | |
| 53. Information overload (infoglut) | |
| 54. Capability for global tele-education | |
| 55. Computer potential for tutoring and improved learning | |
| 56. Computers to displace teachers, doubling student/teacher ratio by 2003 | |
| 57. Decline of reading | |

VIII. Knowledge

- | |
|---|
| 58. Computers facilitate scholarly research and coordinate library acquisitions |
| 59. Weather forecasting improved |

X. Individual and Society

- | |
|--|
| 72. Living patterns dispersed; travel demand increased |
| 73. Electronic devices encroach on commons of speech |
| 74. New structure of societal interaction not based on locality; no sense of place |
| 75. Changed roles of men, women, and children |
| 76. Perceptual numbing |
| 77. Privatization of information exacerbates inequalities |
| 78. Monitoring and decreased privacy |
| 79. Humanized machines to liberate people, amplify the brain |
| 80. Human-machine interactions as dehumanizing and isolating |

Source: Michael Marien ed., Future Survey Annual 1985, Maryland: World Future Society, 1986, pp. 186-187. Copyright, World Future Society, 4196 St. Elmo Avenue, Bethesda, MD 20014, used with permission.

The items in this list range from the profoundly important to the commonplace. But taken together, all these items give some greater definition to the common assertion that new information technologies are having a profound impact on society.

Aside from its breadth, the most striking thing about the list in Table 4-1 is that it is full of contradictory assertions. For example, will the information revolution give us:

- more jobs or fewer jobs?
- more "smart" jobs or more "dumb" jobs?
- improved learning, or "infoglut" and "meaning lag"?
- centralization or decentralization?
- humanization or dehumanization?
- faster Third World development or an undermining of Third World economies and cultures?
- dramatic productivity gains or a destabilized international financial system?

These are all obviously crucial questions for the future of our society. What determines which way things will go? Is it simply a matter of what the "impacts of technology" will be on society? In most areas of life the impact of information technologies will be determined by a larger set of social and economic decisions.

In education, for example, some fear that the "computerized classroom" will overemphasize rote learning because it is easy to create programs that drill and test. Some fear the computer's presentation of material in static patterns, with right/wrong answers for everything, could encourage intellectual conformity. Others believe computers offer potentials for more active learning, less mental drudgery, individually tailored learning, and more independent learning. Still others go further and argue that it is possible to design computer tools for learning that will enhance our

creativity and our ability to do holistic, big picture thinking.

Some fear that, in the face of limited human capacity for processing information, new information technologies will just create more information overload and impede meaning, preventing us from making sense of things. Others believe we can utilize information technology to achieve the new kind of literacy described in Section 5 that will include the competence to search out, analyze, and synthesize the information we need.

Who is right? Or, a better question may be: How can we steer education in the way we want it to go? It seems plausible that computers could skew classrooms toward rote learning, but if we are alert to this possibility we can turn our efforts toward using computers in more creative ways. Information overload is a growing problem, but used skillfully, new information technologies could help us cope with it. In other words, what happens in education depends less on the technology itself, which embodies a great variety of potentials, than on how we choose to use it. How we choose to use technologies will depend upon our decisions about learning needs for living in a knowledge-based society, curriculum design, and even the proper functions of schools in our society.

Or consider the subject of work. It is possible that between now and the end of the century manufacturing and office automation and the proliferation of expert systems will eliminate far more jobs than they create (e.g., the use of computer-assisted design software may eliminate many of the 300,000 draftsmen in the US). And the new economy may well create more low-skill, low-wage jobs than better ones. For example, between 1982 and 1995 there will be an additional 6 million professional and technical jobs created according to Bureau of Labor Statistics estimates. However, the only other categories that will have large growth, 6 million each, will be clerical

workers and service workers, both categories with relatively low pay scales (1). As a result, it is plausible that we could evolve toward a society divided between "gods and clods" -- an extremely busy elite of managers and professionals and a large majority of lower-level workers, many of them displaced from previous jobs and now mobile in a downward direction (2). It is also possible that in the decades ahead, unemployment (not downward mobility, but lack of jobs) will become a pervasive problem.

Although employment impacts are uncertain, let us assume that high-technology does have a significant effect on employment over the long run. There are still many options for action. One approach is to intentionally stimulate the creation of more jobs. We could establish retraining programs and new institutions to broker people and jobs. We could adopt policies to stimulate small business, or launch large-scale projects such as rebuilding the nation's infrastructure.

A second approach is to make better use of existing job slots. We could encourage part-time work and work-sharing. We could shorten the work day or work week, take longer vacations, allow more pregnancy and child care leave, and provide sabbaticals for learning and community service.

A third approach is to increasingly divorce income distribution from employment and foster new ways, besides jobs, of participating meaningfully in the activities of society. To distribute income, employees could be encouraged to purchase stock ownership plans (ESOPs). An even more direct approach would be through a guaranteed annual income or a negative income tax program. We could open up new avenues of social participation by giving incentives to corporations and foundations to support activities in the voluntary sector. Many other strategies are possible (3).

Each choice in this menu of alternatives would take us toward a different social future. In some cases the role of government would expand; in others

it might contract. Some choices would encourage small business; others would foster large private or public enterprises. In the long run, the principal choice may be whether to use employment or other strategies to allow people to meet their basic needs. The point is that what happens depends on what we do, not simply on the inexorable impacts of technology.

We believe this is the lesson that can be drawn from looking at the impacts of information technology on any other aspect of life. What happens will depend more on the larger context of value choices and actions by business and government than on the technology itself. Section 6 will integrate this larger context of choices into multiple scenarios.

THE INFORMATION SOCIETY AS A MAJOR SOCIETAL TRANSFORMATION

A second way to look at the societal implications of the information revolution is to examine the thinking of social theorists who are attempting to see what the whole adds up to, how the information revolution relates to the overall patterns of change in our society.

Many leading future-oriented thinkers believe the present period represents a critical transition in the evolution of human society and that information advances are an important part of that transition. Table 4-2 contrasts the different images of "transformations of civilization" set out in the following major studies of the future (4):

- Daniel Bell, *The Coming of Post-Industrial Society*
- Alvin Toffler, *The Third Wave*
- John Naisbitt, *Megatrends*
- Willis Harman and O.W. Markley, *Changing Images of Man*
- Yoneji Masuda, *The Information Society*

Table 4-2: The Information Society & Transformation of Civilization

Theorist	Transformations of Civilization		
Daniel Bell	Pre-Industrial	Industrial	Post-Industrial
Alvin Toffler	First Wave	Second Wave	Third Wave
John Naisbitt	Agricultural Society	Industrial Society	Information Society
Willis Harman and O. W. Markley	Pre-Modern	Modernization	Information Society -or- Learning Society -or- Failure Futures
Yoneji Masuda	Agricultural Society	Industrial Revolution	Information Revolution 1) Automation 2) Knowledge Creation 3) System Innovation

Source: Institute for Alternative Futures

Many other studies could be included in this list (5). But this grouping allows for a comparison of major viewpoints and provides a basis for considering the scenarios in Section 6.

Each of these observers believes that we are passing through a transition as great as the largest changes of the past. They compare today's changes to the invention of agriculture, which created the food surplus that allowed cities and civilization to come into existence after 4 million years of pre-civilized life, and to the Industrial Revolution, which came 10 thousand years after the invention of agriculture. They all believe that the present transition is happening at a tremendously accelerated rate in roughly the length of a long human lifetime. John Platt, another futurist who shares this general outlook, believes that we live in a "singular epoch"(6).

"Anyone who is willing to admit that there have been sudden jumps in evolution or human history, such as the invention of agriculture, or the Industrial Revolution, must conclude... that we are passing through another such jump far more concentrated and more intense than these..."

All of these future-oriented observers also believe that information is playing a pivotal part in this social transformation. The changing role of information and information technology in society is central to all their theories. While these future-oriented thinkers all agree that a new stage of civilization is emerging, with information playing a critical role, their views differ on fundamental matters: the key "driving forces" for societal change, the central features and overall pattern of today's change, and the extent to which we can steer this juggernaut of change. [For a summary comparison of Bell, Toffler, Naisbitt, Harman and Markley, and Masuda, see Table 4-3].

Driving Forces for Societal Change

In sociologist Daniel Bell's classic theory of the emergence of Post-Industrial Society, the critical driving force for change is the codification of theoretical knowledge through science and the emergence of systematic disciplines of knowledge. The key aspects of change -- the exponential growth of science, systematic R&D, and new intellectual technologies -- flow directly from the codification of theoretical knowledge.

In futurist Alvin Toffler's theory of the Third Wave, the key driving force is growing complexity and diversity in our social and economic life. In his view, societies based on the Industrial Revolution became "massified" and homogeneous with mass production, mass markets, mass education, mass media, mass entertainment, and mass political movements. But since the late 1950's the key aspect of change has been "demassification": more variety of goods and services, niche markets, more special-interest newsletters and magazines

Table 4-3 Differing Images Of Societal Change

	Daniel Bell	Alvin Toffler	John Naisbitt	Willis Harman O.W. Markley	Yoneji Masuda
DRIVING FORCE FOR SOCIETAL CHANGE	Codification of theoretical knowledge.	Growing socioeconomic complexity, diversity, heterogeneity.	Changing structure of industry and society.	Growing realization that things "won't work" if we continue industrial world view; emerging vision of a better society.	Development of Computer.
KEY ASPECTS OF CHANGE	Exponential growth of science, systematic R&D, new intellectual technology.	Demassification - of production, distribution, media, entertainment, politics, lifestyles, etc.	Information jobs now dominate; emergence of information as the strategic resource.	Deep, profound, hard-to-see shifts in metaphysical assumptions and values; in the hierarchy of information types (data, information, knowledge and wisdom) a growing emphasis on wisdom.	Shift from producing "material values" to producing "information values".
OVERALL PATTERN OF CHANGE	Growth of quaternary, primary sectors; information as key resource; knowledge elite; new possibilities for national planning; future orientation; no near term major changes in beliefs, values, goals, behavior.	Shift from massification to demassification, standardization to customization, specialization to holism, synchronization to desynchronization, concentration to dispersion, maximization to optimization; growing diversity in all aspects of life.	Shifts from industrial society to information society, forced technology to high tech/high touch, short term to long term, centralization to decentralization, institutional help to self-help, representative democracy to participatory democracy, hierarchies to networking, North to South, Either/Or to multiple option.	Emergence of new positive images of the future to power cultural change with characteristics such as: holistic perspective; ecological ethic; self-realization ethic; multidimensional and integrative; balancing satisfactions (not along many dimensions (not just material success); experimental and open-ended.	Growth of information, information technology, information utilities, matrix organizational structure, synergistic communities, multi-centered power, participatory democracy, citizens' movements, creation, self-discipline social contribution, of globalism, symbiosis of humanity and nature.
OUR ABILITY TO STEER CHANGE	Meritocratic elite can influence change; more centralized decision making necessary; Bell's forecasts lack alternative futures that are fundamentally different from each other or discontinuous with present trends.	The vast "Third Wave" of change cannot be resisted, will sweep aside power structures and Institutions of Industrial Second Wave Society. Effort still needed to ensure the new order will be benign, e.g. it will not necessarily be more democratic.	Large patterns of change are occurring that we need to understand and go with. Potentials of information age are not absolute - it will succeed or fail according to socially responsible action and the principle of high tech/high touch. Participation increasingly essential for adaptive change.	Growing problems will force drastic changes, but they could go in many directions, including societal collapse, authoritarianism. Emerging positive images now a major social force, but success is not assured. Smooth transition will be possible to extent everyone understands the need for it, sees benefits, feels they are contributing to it. Successful transition could create an "information rich society," but success more likely with a spiritual deepening and outbreak of creativity that would create a "learning society."	A considerable danger that information technology will be used to create a controlled society. To avoid this, we must devote ourselves to a Renaissance of social improvement.

Source: Institute for Alternative Futures

and channels for electronic narrowcasting, more diverse family styles, single-issue politics, more numerous ethnic, racial and group identities, and so on. We are demassifying the mass society, creating a far more complex and heterogeneous society, and it is this heterogeneity that demands higher levels of information flow to coordinate the new, more differentiated social order.

John Naisbitt, like Toffler, believes social development rather than technological change is leading the way into the Information Society. "Today's information technology," he says, "did not bring about the new information society. It was well underway by the late 1950's. Today's sophisticated technology only hastens our plunge into the information society that is already here" (7). For Naisbitt, the key aspects of change are the rise to dominance of the information sector of the economy and the emergence of information as the key strategic resource in the economy.

Futurists Willis Harman and O.W. Markley, both at SRI International when they wrote Changing Images of Man, emphasize the dilemma-like nature of current problems: we want to keep up economic growth, but the impacts of the kind of economic growth we have had in the past are increasingly intolerable; we want to back away from government controls, but the impacts of our technologies grow and demand more regulation; we depend on jobs to distribute wealth and provide meaningful social roles, but manufacturing and office automation are eventually going to eliminate many of the jobs we have today; we dislike the idea of income redistribution, but the rich-poor gap between us and the Third World is likely to have intolerable consequences over the next few decades. These problems are dilemma-like because they cannot be resolved within the framework of industrial technologies and the industrial era's world view. But new technologies and worldviews are emerging, and the combined force of worsening problems and new, attractive images of the future will be

Table 4-4: Daniel Bell's General Schema of Social Change

	PRE-INDUSTRIAL	INDUSTRIAL	POST-INDUSTRIAL	
REGIONS:	Asia Africa Latin America	Western Europe Soviet Union Japan	United States	
ECONOMIC SECTOR:	PRIMARY EXTRACTIVE: Agriculture Mining Fishing Timber	SECONDARY Goods Producing Manufacturing Processing	TERTIARY Transport Recreation QUINARY Health Education Research Government	QUATERNARY Trade Finance Insurance Real Estate
OCCUPATIONAL SLOPE:	Farmer Miner Fisherman Unskilled worker	Semi-skilled worker Engineer	Professional and technical Scientists	
TECHNOLOGY:	Raw materials	Energy	Information	
DESIGN:	Game against nature	Game against fabricated nature	Game between persons	
METHODOLOGY:	Common sense experience	Empiricism Experimentation	Abstract theory; models, simulation, decision theory, systems analysis	
TIME PERSPECTIVE:	Orientation to the past; Ad hoc responses	Ad hoc adaptive- ness, Projections	Future Orientation Forecasting	
AXIAL PRINCIPLE:	Traditionalism: Land-resource limitation	Economic growth: State of private control of investment decisions	Centrality of and codifi- cation of theoretical knowledge	

Source: Daniel Bell, CPIS, p. 117 as cited in Larry Hirschhorn, "The Future of Long-Range Planning in the United States: A Pessimistic Scenario," World Future Society Bulletin, Vol. 13, No. 1, Jan-Feb. 1979, pp. 8. Copyright World Future Society, 4916 St. Elmo Avenue, Bethesda, MD 20014. Used with permission.

the driving forces for change. Harman and Markley believe the key changes need to be at the metaphysical and value level. In the hierarchy of information types (data, information, knowledge, wisdom) we need to integrate the lower levels of information with the perennial wisdom, the highest values found in every civilization, and create a more wisdom-oriented society.

For Yoneji Masuda, the key driving force is the computer. Whatever shifts toward information occupations may have happened before, he believes, it is the computer that creates the possibilities for a radically new society.

Overall Pattern of Change:

The overall pattern of change envisioned by Daniel Bell is the most conventional of this group of social theorists. While he anticipates major structural changes like the growth of quaternary and quinary sectors of the economy (see Table 4-4) he does not anticipate major changes in beliefs, values, goals, or social trends. He essentially accepts the view of the late futurist Herman Kahn that the "long-term multifold trend of Western culture" is likely to continue, taking us toward meritocratic elites, centralization of economic and political power, increasing military capability, Westernization, affluence, urbanization, and social engineering (8).

The other theorists listed above anticipate changes that take our society in fundamentally new directions. For Toffler, the defining characteristics of Industrialism -- massification, standardization, specialization, synchronization, concentration, and maximization -- are all being virtually reversed. Naisbitt's "megatrends" are all new directions since the 1960's. And while some of Naisbitt's trends do not seem to have the force they appeared to have in 1980, especially the trend from North to South, they basically confirm Toffler's analysis.

While Toffler and Naisbitt consider value shifts, they become central

for Harman and Markley, who see value-based positive images of the future as the key to successfully coping with our worsening dilemmas and problems. Harman and Markley try to identify the general characteristics of an image of the future that would have a possibility of resolving these problems, such as: a holistic perspective; an ecological ethic; a self-realization ethic; a capacity to integrate apparently opposing views in a new synthesis; a balancing of satisfactions along many dimensions of life without overemphasizing the satisfactions of wealth and "things;" and a society that is deliberately open-ended and experimental rather than dogmatic.

Yoneji Masuda, who developed "The Plan for an Information Society: Japan's National Goal Toward the Year 2000," sets out perhaps the most radical vision of all. He foresees the Information Society emerging through three stages. In the first stage, automation, traditional mental and physical labor will be increasingly accomplished through the application of information technology. In a second stage, knowledge creation, our mental capabilities will be amplified in a way that will allow us to solve problems, create opportunities and do things we could never do before. In a third stage, system innovation, Masuda foresees epochal changes in the economy, politics, and society, above all an emphasis on creativity, life-long self-learning, and what he calls "knowledge-creative education."

Ability To Steer Change: The writings of Bell, Toffler, and Naisbitt often have a tone of "inevitable change," but in fact all these social theorists believe that to some extent we have the power to guide our society's evolution. Toffler warns that, while sweeping change is inevitable, it will not necessarily bring a more democratic society. Naisbitt says the technology of the new information age is not the determining force: it will succeed or fail according to the principle of high tech/high touch -- that is, it will

succeed if it is guided by a true concern for people and their real needs and potentials.

Harman and Markley believe that worsening problems will force drastic changes that could go in any number of directions, from societal collapse or a more authoritarian society to a highly positive social transformation. How smoothly this transformation can be accomplished will depend on the extent that everyone understands the need for it, sees benefits from it, and feels they are contributing to it. A minimal transformation might get us through to a stable "Information Society," but our chances of success would be higher if we could achieve a spiritual deepening and an outbreak of creativity that would take us to a "Learning Society."

Masuda believes that the information technology capabilities now coming into existence create a considerable danger that we will move toward a controlled society. The only way to avoid it, he believes, is through a Renaissance of social improvement. For Masuda there is no middle ground, no muddling through. Before the new technological infrastructure is fully established, we must dedicate ourselves to achieving this Renaissance or else we will find ourselves in the "Automated State." Our own vision and determination and effort will make all the difference.

In Section 6, the "High-Tech Information Society" scenario plays out a future similar to that envisioned by Daniel Bell and Herman Kahn. The "Creative Society" scenario draws on the images forecast by Toffler, Naisbitt, Harman and Markley, and Masuda.

The future may not prove to be as optimistic as these images portray it. Toffler, Harman and Markley, and Masuda all warn of problems and dangers ahead, including the possibility of using information technology to create a more authoritarian society. In Section 6, the "Things Bog Down" scenario explores a less optimistic future, and the "1984 and Beyond" scenario explores

the possibility of creeping authoritarianism. The scenarios present four distinct pathways for the information revolution and society, and many more pathways can be imagined that blend various elements from these four futures.

CHOOSING THE INFORMATION SOCIETY

This review of several of the most important whole-system images of society suggests that the range of possibilities for positive social change may be much greater than we sometimes imagine. The four scenarios in Section 6 should aid you, the reader, in developing your own preferred image. Attractive, coherent images of the future exert upon the present a kind of "magnetic pull" toward the future, bringing themselves into existence. This is the central insight of the European cultural historian and futurist Fred Polak. As Polak puts it (9):

"The rise and fall of images of the future precedes or accompanies the rise and fall of cultures. The image of the future can act... as a regulative mechanism which alternately opens and shuts the dampers on the mighty blast-furnace of culture. It not only indicates alternative choices and possibilities, but actively promotes certain choices and in effect puts them to work in determining the future... The task before us is to re-awaken the almost dormant awareness of the future and to find the best nourishment for a starving social imagination...."

If Polak is right, our own images of the future of the information society help to shape the information society. If so, we need to take care that our images are worthy of the generations ahead.

Notes

1. Clement Bezold, Jonathan Peck, and Rick Carlson, The Future of Work and Health (Dover, MA: Auburn House, 1986), pp. 28-32.
2. Martin Morf, "Eight Scenarios for Work in the Future," The Futurist (June 1983), pp. 24-29.
3. Robert L. Olson, "Science and Technology" in Sandra Chizinsky and Peter Whitten, eds., Time's Harvest: Exploring the Future, International University Consortium for Telecommunications in Learning (Lexington, MA: Ginn, 1984), p. 75.
4. Daniel Bell, The Coming of Post-Industrial Society (New York: Basic Books, 1973). Alvin Toffler, The Third Wave (New York: William Morrow, 1980). John Naisbitt, Megatrends (New York: Warner Books, 1982). Willis Harman and O.W. Markley, Changing Images of Man (New York: Pergamon, 1985). Yoneji Masuda, The Information Society (Bethesda, Md.: World Future Society, 1981).
5. See for example Simon Nora and Alain Minc, The Computerization of Society (Cambridge: MIT Press, 1980); Sheridan Tatsuno, The Technopolis Strategy: Japan, High Technology and the Control of the 21st Century (New York: Brady/Prentice Hall, 1986); and Theodore Roszak, The Cult of Information (New York: Pantheon Books, 1986), p. 6. John Platt, "The Acceleration of History," The Futurist (February 1981), p. 19. John Naisbitt, Megatrends (New York: Warner Books, 1983), p. 13.
6. John Platt, "The Acceleration of History," The Futurist (February 1981), p. 19.
7. John Naisbitt, Megatrends (New York: Warner Books, 1983), p. 13.
8. For Kahn's full definition of the long-term multifold trend of Western culture, see Herman Kahn and B. Bruce-Briggs, Things To Come (New York: Macmillan, 1972), pp. 8-9. 8. Fred Polak, The Image of the Future quoted in Michael Marien, ed., Future Survey Annual 1985 (Bethesda, MD: World Future Society, 1986), p. iv.
9. Fred Polak, The Image of the Future quoted in Michael Marien, ed., Future Survey Annual 1985, (Bethesda, MD: World Future Society, 1986), p. iv.

5. INFORMATION POLICY

This section explores four of the most important policy issues that will be critical between now and the year 2000. The four issues examined here - privacy, the role of government, intellectual property rights, and information literacy - emerged as the four public policy issues rated "most important for the future" at a workshop the Institute for Alternative Futures conducted at the Information Industry Association's BOCA IV conference in 1986.

The way these information policy issues are dealt with will effect the whole society as well as the information industry. They involve the health of our economy and the protection of our freedoms. How these issues are resolved will depend on efforts made by the government and the information industry itself. Therefore information policy should not be approached in terms of prediction, but rather in terms of understanding options and taking responsibility for creating a "preferred future."

The information industry will play a central role in defining and resolving these issues. It could do this most effectively by joining in discussion with others who are heavily involved in information, including public officials, academic experts, and consumer representatives. New kinds of broad-based, non-adversarial forums could be highly effective in clarifying information policy issues and defining alternative directions. One purpose of this report is to help stimulate such a discussion.

Three Basic Characteristics of Information Policy Issues

Information policy issues have three characteristics that, while not unique to this policy area, are important to keep in view. First, information policy is not guided by a national overarching goal, like "energy independence," or by a coherent national plan, like the plan for interstate

highways.

Second, information policy issues contain large, inherent uncertainties about technology and market behavior. Large uncertainties can lead reasonable people to quite different judgments about the nature and seriousness of issues and the most effective ways to resolve them.

Third, information policy choices are usually not between "good" and "evil," but between legitimate and competing values, goals and interests. As a result, these issues are not likely to be resolved completely in favor of any polar position. The challenge at any particular time is to strike an "appropriate balance" among the conflicting values and interests.

These basic characteristics have an important implication: the long-term resolution of information policy issues must involve the participation of all stakeholders' points of view.

In the following review of policy issues, we do not attempt to predict the situation in the year 2000. Rather, we attempt to clarify different views of each issue, show why it is likely to be a prominent issue in the year 2000, and discuss the nature of the "appropriate balance" that needs to be found to resolve the issue. Then, for each issue, we use the scenarios in Section 6 to develop four possible alternative "paths" that it might take between now and the year 2000.

PRIVACY

We believe that privacy is the one issue with the greatest potential to take the Information Revolution in dangerous directions. As a result, we have constructed one of the four scenarios in this report, "1984 and Beyond," around the possibility that information technology will be misused for purposes of social control. There is no way to estimate the likelihood of such a development, for it depends on what we do.

Different Views of the Privacy Issue

Some believe that the private sector poses the greatest threat to individual privacy. In this view, government record keepers are at least restrained by a substantial body of law, while private sector record keepers are less constrained by law. Others believe the threat derives far less from the private sector than from the potential for government abuse. In this view, it is the ability to invade privacy combined with the power of the state that is truly dangerous.

Privacy is the number one public concern related to information technology and the information industry. In The Road After 1984, a research report done for Southern New England Telephone, pollster Louis Harris found that more than three-quarters of the public say they are "very" or "somewhat" concerned about threats to their personal privacy. The public most frequently accuses credit bureaus and the government of breaching their privacy. They believe the other biggest threats to the confidentiality of information about them come from loan companies, insurance companies, banks, public opinion research firms, and government welfare agencies. Majorities of the public and all leadership groups believe that files with personal information about themselves are being kept "for unknown purposes." Vast majorities of the general public believe it is now possible to link data from many sources into master files, and they believe such files are an invasion of privacy. Almost seven out of ten of the public believe that unless privacy is better protected, a society resembling George Orwell's Nineteen Eighty-Four is at least "somewhat close" (1).

Despite these views among the general public, there is a surprising lack of consensus among experts and leadership groups about the seriousness of the privacy issue. Below is a sampling of the many shades of opinion.

Some believe privacy is already a critical problem, at least within the executive branch of the Federal Government. Over a decade ago, former Senator Sam Ervin already feared that the

...unlimited possession of the resources to build and operate data banks on individuals, and to make decisions about people with the aid of computers and electronic data systems, is fast securing to executive branch officials a political power which the authors of the Constitution never meant any one group of men to have over all others. It threatens to unsettle forever the balance of power established by our Federal Constitution (2).

Some believe privacy is already a rapidly growing problem in the private sector. A decade ago, privacy concerns about credit bureaus led to federal regulation. Ronald Plessner of the law firm Blum, Nash & Rainsback predicts that the next big private sector privacy issue will involve the sharing of information from medical records (3). AIDS and drug testing are starting to call attention to medical record privacy issues. Total genetic profiles, which many biomedical researchers believe will be possible by the year 2000, will raise unperceived issues of medical information privacy (4).

Privacy is not just a potential big business problem. Small businesses, operating in computer networks, could be a growing problem, too. For example, small companies working with landlords now create "renter databases" with names of people who have ever made grievances or taken legal action against landlords. These databases contain no information about the validity of the renters' charges. Other small businesses are creating "patient databases" of people who have ever filed malpractice suits. There are right wing groups creating electronic databases on suspected traitors.

Some are concerned about the potential for future dangers. "Social conditions may change," warns Gary Marx, a professor of Sociology at MIT, "a more repressive government or a less tolerant public may gain sway in the

United States - perhaps because of a severe economic downturn, immigration pressures, or a major foreign policy or military defeat. Under such conditions, today's surveillance systems - and tomorrow's more powerful ones - could easily be used against those with the 'wrong' political beliefs...." (5).

Some fear that privacy problems will grow so slowly and subtly that we will fail to notice them. Emotion-laden issues such as AIDS, terrorism, a "war on drugs," and reducing welfare fraud will slowly push privacy aside. We will become numbed by many small intrusions in seemingly unrelated areas, and become indifferent to them (6).

Some emphasize subtler privacy dangers. David Burnham, author of The Rise of the Computer State, fears that unless our growing technical capability for surveillance and record keeping is balanced by privacy protections and greater tolerance, deviants and past wrongdoers may be increasingly discriminated against in employment and personal associations.

The knowledge that one cannot discard one's past, that advancement in society depends heavily on a good record, will create considerable pressure for conformist actions. Many people will try harder than they do now to keep their records clean, avoid controversy or 'deviant' actions, whatever their private views or inclination. Diversity and social vitality is almost certain to suffer, and in the long run independent private thoughts will be reduced (7).

Some, like Lewis Branscomb of IBM, believe privacy rules are necessary as the amount of personal information collected increases, but do not believe that the computer, in itself, makes the privacy problem worse. "It turned out," Branscomb believes, "that the computer is a much better technology than the filing cabinet for controlling information access, so the computer became a solution to the privacy protection issue, rather than the problem" (8).

Information in machine-readable form does reduce access to the human eye, and computer security measures can help in privacy protection (9).

Others hold a still more sanguine view. For example, some believe we will simply get used to living in a much more "information-open" society where the widespread use of personal computers can give individuals rough information parity with the government and corporations. In such a society, if you have done nothing wrong, you have nothing to hide (10).

To add to this confusion, there appears to be no consensus about what privacy is, no unifying concept to explain why certain types of information are legally protectable. After a detailed review of the legal status of the concept of privacy, Meredith W. Mendes of Harvard University's Program on Information Resources Policy concludes that:

The constitutional concept of privacy is nebulous and unpredictable. The common law is outdated, has doubtful application to information technology, and is subject to privileges and immunities. Federal statutes are riddled with exceptions and holes... State statutes vary in coverage... No statute adequately defines privacy (11).

While privacy is difficult to define in precise, legal terms, the concept does have a generally understood meaning. The Congressional Office of Technology Assessment (OTA) states it in the following way: "...it appears to mean, to most people, the ability to keep certain kinds of personal information from other people or to restrict its use, except as one freely chooses to permit its disclosure or use" (12). The kinds of personal information that might be identified as "private" under such a definition include information relating to one's own buying habits; financial transactions; information and entertainment sources (books, programs, newspapers, magazines, movie selections, database searches); health,

medications, and related data; intellectual material relating to one's employment; and unpublished written and oral communications (13).

Why Privacy Will Be a Prominent Issue in the Year 2000

There are many reasons to believe privacy will continue to be a prominent issue in the year 2000.

A new information infrastructure is rapidly being put into place where people leave an electronic trail of transactions with various institutions - educational, retail, financial, governmental, professional, criminal justice, and others. This electronic trail can be stored cheaply, in perpetuity.

The ability to interconnect and match many databases is becoming cheap and easy. The cost and time required to match or link paper records was prohibitive, but computer-based record systems overcome these barriers. The computer networks needed for linking myriad databases are already in place. For example, the federal government now shuttles data over 300 networks as part of its routine operations (14).

Computer networks shared by many unrelated users and organizations give potential access to the files of every organization in the network, unless an organization installs security measures on its files. And as networking has grown, so has the "user friendliness" or ease of accessing data from networks. As a result, networks have "exponentially increased the potential for unauthorized access, misuse, and disclosure of personal information among private and government agencies, commercial information providers, and hackers" (15).

New information technology applications such as the automated office, an automated securities exchange, or in-home information services create whole new environments for privacy issues to arise. A number of other new information technologies such as cordless and cellular phones, electronic

mail, pagers, and local area networks (LAN's) are highly vulnerable to eavesdropping for investigative, competitive, or personal reasons.

Some emerging technologies could easily be misused, and even their legitimate use raises novel issues. For example, expert systems being developed for "profiling" and identifying potential lawbreakers could also be used to identify potential political dissidents. A recent report from the Office of Technology Assessment concluded that "important privacy and constitutional implications are raised by computer profiling because people may be treated differently before they have done anything to warrant such treatment" (16). As Jerry Berman of the American Civil Liberties Union's project on privacy and technology puts it, "When Newsweek makes a mistake doing a computer profile of its subscribers, the worst that can happen is that you get junk mail. When the government does it, you may be subjected to an intrusive investigation" (17). The legal status of expert system recommendations may become a controversial issue; for example, can the recommendation of an expert system create a sufficient "probable cause" to justify a search warrant or arrest?

The use of computerized record systems, data-linkage, electronic surveillance technologies, and computer profiling is growing rapidly. The five largest credit-screening companies hold computer-based records on more than 150 million individuals. The health records of nine of ten working Americans are held in the computers of their insurance companies (18). Based on a survey of Federal agencies (excluding all intelligence and counterintelligence agencies), the Office of Technology Assessment found that about 25 percent (36 out of 142) of Federal agencies use computerized record systems for law enforcement, investigative, or intelligence purposes. Eighty-five federal databases contain about 288 million records on 114 million persons. In addition, about 25 percent (35 out of 142) indicated some current

or planned use of various electronic surveillance technologies (19).

State and federal governments have established over 500 programs to compare information from two or more sources (20). For example, the IRS is gathering a variety of computerized commercial lists, including data on real-estate transactions and new car buyers. Anyone on those commercial lists who has not filed a tax return will be hearing from the IRS.

The most controversial computer matching effort is related to the Federal government's effort to combat welfare fraud. The states are being required to establish "income verification programs" which will allow welfare workers to check a welfare applicant's finances by examining Social Security wage records, state unemployment wage and benefit records, and some IRS records. Most states are also giving social workers direct access to state wage information, property records, motor vehicle records, and public school enrollment records. The Office of Management and Budget (OMB), which is overseeing this massive data-linking effort, is encouraging states to provide welfare workers access to bank records, private credit-checking agencies, hospital records, and various commercial databases (21).

The OMB insists that the Federal government is setting up "54 state/territorial systems, each operating independently," but critics argue that the federal government is using computer matching to create a de facto national data bank through state governments. When Congress banned the creation of a national data bank a decade ago, it had in mind a huge mainframe computer containing millions of electronic dossiers. With the proliferation of minicomputers and microcomputers linked in computer networks, however, the notion of a single data bank has become technologically obsolete. With computer matching, a skilled investigator can quickly pull together hundreds of independent sources of information. In short, we now have a national data

network that can do the same things as the national data bank Congress rejected before (22).

A seemingly innocent but chilling example of the abuse of computer matching has been provided by Pete Earley, a staff writer for The Washington Post Magazine. The example is fictitious, but it is not the stuff of fantasy. It is meant to illustrate the capabilities now coming into place as a result of the Federal government's efforts to reduce fraud in welfare programs.

WATCHING ME, WATCHING YOU

John first spotted her on his commute to work: mid-thirties, chestnut hair, driving a steel-blue Mercedes with a vanity plate that read Mine.

He rushed to his office, turned on his computer, pulled out his file of codes and went to work. Tracking down this beauty would be cinch, he muttered to himself, scanning in his mind the access he had as a social worker to numerous public and confidential government records. Checking out people had become a natural part of his day - it was part of his job to separate valid welfare applicants from chiselers. John pressed a few buttons on the keyboard, entered the authorizing code, hit the "execute" button, accessed files from the Department of Motor Vehicles, typed in the license tag M-I-N-E, pressed the "search" button and waited. It seemed like forever, then, filling the screen like magic was this: License tag: MINE. Vehicle: 1984 Mercedes Benz 190e. Owner: MARCI HAMILTON. 2727 Skyline Drive. Drivers License No. 524-64-6789. Date of birth: 9-5-51. Sex: Female. Weight: 105. Height: 5-6.

John smiled. He knew from experience that the number on Marci Hamilton's license was also her Social Security number. He entered 524-64-6789 on the keyboard and told the computer to search wage records that employers are required to file every quarter with state unemployment compensation and tax offices: 524-64-6789. MARCI HAMILTON. Employer: Bivens Manufacturing Co. From: 5-26-76 to current. Position: National Sales Director. Gross pay 1985: \$66,134. First Quarter earnings: \$16,526.

Not bad, John thought. He typed Marci's address into the computer and told it to search the local Register of Deeds' records: 2727 Skyline Drive. Block 221, Lot 5. Land Assessed: 25,072. Improved Assessment: 65,251. Total Assessment: 90,323. Built 1980. Use: residential. Deed of Trust recorded: 11-3-81. Loan Instrument: 23489. Amount: \$65,000, between Albert Jacob and Marci Hamilton Stratford, and First National Security Bank. Other personal assets: 25 foot sailboat, assessed at \$15,000.

John paused. Marci Hamilton had once been Marci Stratford. He decided to check county divorce records: Divorce 5-7-85: Marci Hamilton Stratford versus Albert Jacob Stratford. Married 12-7-78. Number of Children: two; Andrew Thomas: born 5-5-79; Lynn Carroll Richards,

born: 7-8-75. Grounds for divorce: infidelity. Divorce sought by : wife. Custody of children: wife. Race: husband; Caucasian; wife; Caucasian. Number of previous marriages: husband; none, wife; one. Date first marriage was terminated: 9-5-76. Place: Reno, Nev.

John considered linking his computer with the State Data Exchange Network, which would give him access to records in other states, such as Nevada, where Marci's divorce had been granted. Instead, he decided to search local school enrollment records for information about her children. Student enrolled: Lynn Carroll Richards, Somerset School for the Deaf...Andrew "Andy" Thomas Stratford, Thomas Edison High, morning; Tri-Area School for Gifted and Talented, afternoons.

John decided to check federal records from the Internal Revenue Service next. Because IRS files are confidential, he could not connect his computer to the IRS computer in Washington. Instead, he put Marci's name on a list that was mailed by the state welfare office to the IRS the next day. A short time later, John received a computer tape from the IRS that contained tax information about Marci's unreported income:

FORM 1090, UNEARNED INCOME:

INTEREST: \$2,500 from 25,000 C.D., First National Bank; \$5,000 from \$50,000 C.D., First National Bank; \$3,000 from \$30,000 C.D., Central States Bank; \$200, Landmark Bank, local Savings Acct.

DIVIDENDS: \$1,500, Bevins Furniture, 5,000 shares.

CAPITAL GAINS: \$12,000 sale of IBM stock.

OTHER: \$7,000, rental from house at 100 Lark Avenue; \$5,000 executive sales bonus from Bivens Furniture; \$3,245, winnings from wagers at Highland Horse Race Track.

John reviewed what he had learned. Marci was recently divorced after a six-year marriage. She had filed for divorce after charging her husband with adultery. It was her second marriage. Her 10-year-old daughter, by her first marriage, had a hearing problem. Her 6-year-old son was above-average in school. Marci had an expensive home; secure, high-paying job; rental and stock earnings; a prestige car; and enjoyed sailing and betting on the horses.

John called Bivens Furniture. "Good afternoon, this is Ms. Hamilton," a pleasant voice said. "I don't want to sound too forward," John explained, "but I feel like I already know you. You see, I met some people at a party the other night and they told me

all about you and your little girl Lynn, with the hearing problem, and how Andrew, I mean, Andy, is so smart in school."

"Really, who told you about us?" asked Marci.

"This is really embarrassing," replied John, "I mean really embarrassing, but I don't remember their names. It was a big party, you know. Anyway, they said we had a lot in common."

Source: Pete Earley, "Watching Me, Watching You", The Washington Post Magazine, May 11, 1986, pp. 9-10

Artificial Intelligence (AI) expert system profiling programs are being developed by a broad spectrum of agencies. In the FBI, an AI system called "Big Floyd" is being developed for targeting labor racketeers, arsonists, rapists, and potential serial killers and terrorists, among others. Customs is developing an expert system to target drug smugglers. The Secret Service is creating a classified system to identify potential presidential assassins. The Departments of Defense and Energy are creating systems for identifying corner-cutting patterns of contractor activity. The IRS is building a system to catch tax cheats. The Environmental Protection Agency wants one to identify likely polluters, and the Treasury Department hopes to target money-laundering banks (23).

Far more powerful technologies are likely to be in place by the year 2000. For example, the future technical capabilities identified in our conservative, extrapolative technology forecasts in Section 2 should make possible speech recognition systems capable of monitoring telephone traffic and activating recording and call tracing whenever sensitive topics are discussed. Such systems could be applied to a significant part of the nation's telephone traffic. Already, it is alleged, the National Security Agency can simultaneously monitor some 54,000 telephone transmissions to and from the United States (24).

There is arguably a significant trend toward a loosening of constraints on the government's use of these kinds of technological capabilities. For example, the Privacy Act of 1974 specifies that the government cannot collect information for one purpose and then, without permission, use it for another. But the Federal government's effort to prevent welfare fraud has side-stepped this requirement by stratagems such as defining the data transfers as interdepartmental "assistance" rather than a "transfer of records" (25). Electronic surveillance through the use of bugs and wiretaps is another example: the number of Federal court-approved bugs and wiretaps in 1984 was the highest ever (26).

No integrated set of laws exists to protect individual privacy, especially in the realm of electronic information technologies. Government guidelines for computer matching operations are shifting and unclear. There are no formal policies governing the creation or use of expert system profiles, although agencies may have their own internal guidelines. Policy on monitoring transactions in computer databases is unclear (27).

However, legislation in this area is evolving rapidly. Key legislation includes: 1) The Privacy Act of 1974, which creates rights for subjects of government records and obligations and duties for government record keepers; 2) The Fair Credit Reporting Act of 1976, which mandates specific obligations for private companies that maintain credit information, with an emphasis on getting rid of old records; 3) The Right to Financial Privacy Act of 1978, which establishes court procedures required to obtain personal banking records; and 4) The Electronic Communications Privacy Act of 1978, which extends the protections of federal wiretap law beyond wire-based voice conversations to cover private wireless, data, and video communication as well. More than 30 states have also passed privacy laws. In the related area of computer crime, federal legislation passed in 1984 created criminal

law coverage of federal computers and computers with individually identifiable financial information. The Computer Fraud and Abuse Act of 1986 extends the 1984 law's protections to private sector computers. Hearings were recently held on the Computer Matching and Privacy Protection Act of 1986. No further action was taken, and the bill is expected back in the next Congress.

Finding The Balance

In the light of all these developments and trends, concern for the protection of privacy is clearly justified. The technical potential for privacy abuse will grow rapidly between now and the year 2000, and there is little likelihood that the problem will somehow resolve itself.

On the other hand, our legal system also has strong commitments to values that may sometimes conflict with individual privacy concerns, such as the public interest in law enforcement and the protection of public health. To the extent privacy protections involve restraints on the free flow of information in our society, they need to be balanced with the freedom of speech and press protected in the First Amendment. Business also has legitimate needs to collect, use and disclose information about individuals. If we want to have and use credit, or want to be able to write checks, or want our medical records kept in good order, we cannot ask business to stop gathering certain kinds of information about us. If the concern for privacy is taken as an absolute, the efficient operation of both government and business could be severely constrained (28). The challenge, therefore, is to determine the appropriate balance between the need for privacy protection and other important values in our society.

The information industry can play a critical role in helping to find this balance. No one else better understands the legitimate needs of business and government for collecting and using information, and the dangers of imposing

unnecessary obligations and regulations on business. At the same time, no one is more exposed to the privacy concerns of customers and citizens. For example, the Information Industry Association's support for the electronic Communications Privacy Act recently passed by Congress was based on an awareness that the use of electronic communications systems ("E-Comms") such as electronic mail will be encouraged by prohibiting improper interception or disclosure, so that users can be confident that E-Comms are equal in privacy protection to mail and telephone. Responsible privacy protection is necessary to insure continued growth of the electronic communications industry (29). And finally, no one is in a better position to understand the technical capabilities of emerging information technologies and their potential for misuse.

Information industry action on this issue is relevant at many levels: clarifying the basic concept of privacy; developing policy standards related to the collection of personal information by record keepers, the rights of record subjects to monitor and participate in the record-keeping process, and the confidentiality of personal information; encouraging the development and use of encryption codes, physical security systems, and other measures to improve information security; providing a model of exemplary private sector behavior and fostering industry self-regulation in the form of industry privacy codes (for example, Warner Amex, the cable operator of the Qube system, pioneered a subscriber privacy code in 1981); supporting appropriate legislation, and helping to fine-tune legislation to avoid unnecessary negative impacts on business operations; maintaining vigilance in regard to privacy intrusions by government and business, helping to alert the public to dangers, and refusing to cooperate with activities that may "go too far" in collecting and assembling personal information; encouraging and supporting

public interest groups concerned with privacy protection; and supporting efforts to broaden the concept of "information literacy" to include citizen awareness of their rights to privacy.

THE ROLE OF GOVERNMENT

Different Views of the Role of Government

Views about the proper role of government in information differ dramatically, especially between countries (30). In the United States, however, this debate generally takes place within the framework of a two-part agreement.

There is a high level of agreement that private citizens and private enterprise should play the dominant role in information generation and dissemination. Our widespread belief in the productivity and efficiency of private enterprise leads us to place primary reliance on the private sector and the information marketplace for providing information goods and services. And our traditional distrust of concentrated government power leads us to fear that a dominant government role in providing and controlling information would be dangerous to our freedom.

At the same time, there is substantial agreement that government should play an important information role in our society. In this regard the information industry is different from other industries. The government does not make automobiles or run oil refineries, but it does collect census data and distribute reports of Congressional proceedings. Governments at all levels have long been essentially "information companies," operating public schools, funding public libraries, delivering the mail, and performing many other information services. Federal agencies often have a legal responsibility to disseminate government-generated information specifically written into agency legislation (31).

This two-part agreement -- that the government should play a significant, but not a dominant, information role -- creates an inevitable ambiguity and tension about the proper information roles of the sectors of our society. The increasing importance of information, and the fact that emerging technologies will allow any organization to more easily collect, enhance, publish and distribute information, is likely to increase these tensions and pose almost unique problems in the relationship of the government and the private sector.

Why The Role Of Government Will Be a Prominent Issue in the Year 2000

A few examples illustrate why the role of government in information is likely to be a controversial subject for some time to come.

1. Intelligent Network Regulation: There is a major clash building between public policy and emerging telecommunications technology. Before World War II, telecommunication was based on a system of paired copper wire where it was too expensive to maintain more than one system either for long distance or for local service. Operating the telephone system as a regulated monopoly made sense in terms of the existing technology. Since World War II, microwave and coaxial cable, and then satellites and fiber optics transformed the technology of telecommunications and made a competitive marketplace possible. The government eventually responded by forcing AT&T to divest itself of the Regional Bell Operating Companies (RBOC's) and by deregulating the telephone equipment business.

Another transformation of telecommunications technology is well underway as telecommunications merges with computation to create "intelligent networks." But under today's regulatory framework, the RBOC's - nearly half of the U.S. telecommunications industry - are barred from the information services markets that will be very important in bringing the "intelligent

networks" into existence. This consigns the RBOC's to eventual technological obsolescence. Battles are inevitable over the years just ahead about the extent to which the RBOC's, which continue to control the essential local monopoly telecommunications pipelines, should be permitted to get into the information services field in competition with entrepreneurs who have already entered the field (32).

2. Limitations on Free Expression: Controversies related to the broad area of limitations on free expression are likely to grow between now and the year 2000. While the First Amendment severely limits the power of the government to restrict the content or dissemination of information, these limits are more established for print than for electronic media. The courts have recognized a necessity for various restrictions on free expression. Public interests that can legitimately limit free expression include national security, protection of personal information, protection of copyright, protection of the public from obscenity, and protection of the public from deceptive or misleading commercial information. In regulated media, government can act to achieve greater diversity in the source and type of information disseminated through direct regulation of access to communication channels. All of these areas are in turmoil (33).

3. Budget Pressure: The budget deficit and the Graham-Rudman-Hollings legislation will put enormous pressure on the federal budget over the next several years. This budget pressure could have a large impact on the competitive involvement of government in gathering, manipulating and disseminating information. The pressure could result in the cancellation of many government information offerings, reducing competition from government. This would open up new opportunities for the private sector to provide information, but it could also eliminate some of the government-generated

information that information businesses now use and enhance to create products.

Budget pressure may lead to a very different result: more agencies may be tempted to develop cost recovery programs to offset operating costs by selling more information products or services.

Budget pressure could also produce other problems for the information industry. For example, the Securities and Exchange Commission's (SEC) original proposal for an electronic filing system (Electronic Data Gathering, Analysis and Retrieval or EDGAR) intended that the systems' cost of \$70 million be financed by a private sector provider who would then be allowed to recoup the investment by being given monopolistic control over EDGAR data. This could be an early example of a trend toward government efforts to offload the costs of government automation projects onto the private sector.

4. Information Equity: If economic gaps between the rich and the poor widen in our society, information products and services will be less equitably distributed as well. Changes in access to information alone will not change more basic inequities. But the perception of a growing "information gap" could lead to calls for government remedies.

5. Protecting Business Incomes: Some entertainment businesses are increasingly asking for government intervention to protect their incomes, such as imposing taxes or royalties on blank tapes, or creating a legal requirement for all VCR imports to include circuitry to disrupt or block back-to-back copying of copyrighted video tapes. These solutions to business problems require a greater role for government, and involve the government in handling the administrative costs of ensuring that business incomes are protected. While this government-as-the-bill-collector role for the information industry may seem strange, the establishment of the Copyright Royalty Tribunal in 1978

is a precedent. History has shown that companies and segments of industry will actually seek regulation at different points in their growth to protect or enhance their own market position.

6. Selecting a Model of Society: One of the central ideas in Simon Nora and Alain Minc's landmark report to the President of France, The Computerization of Society, is that emerging information technologies are not inherently centralizing or decentralizing; it depends on how they are configured and used. As Nora and Minc put it: "Data processing offers the means to implement the most diverse schemes, the 'Tout-Etat' (complete centralization of state control) as well as that of extreme decentralization. Thus guiding the acquisition of data processing means selecting a model of society" (34). Is this assertion true? If so, what are the implications for the role of government? These could become much-debated questions between now and the year 2000.

Balancing Government's Roles

There is little question that the Federal government and state and local governments will be involved in the information industry. The basic question is to what extent. Legitimate roles of government include:

1. Acting as an information provider/vendor
2. Acting as an information user/customer
3. Acting as a regulator
4. Acting as a goal-setter

This section focuses on the roles of government as provider/vendor and goal-setter.

1. Acting As An Information Provider/Vendor

For information industry audiences, the "role of government" generally

means the role of government as a competitive information provider and vendor. The kinds of information the government provides include records of government actions (e.g., the Federal Register), educational materials (e.g., Department of Agriculture brochures), statistics collected for public use (e.g., Census, Bureau of Labor Statistics), information collected from government sponsored R&D projects (e.g., Department of Defense-sponsored research on very large scale integrated circuits), information used to influence the political process (e.g., press releases), information compiled from public and private sources to support particular government policies (e.g., Department of Energy analyses of the international oil marketplace), and information compiled to support particular segments of the public (e.g., Index Medicus).

As a vendor, the government also distributes information in many forms: in printed or microfiche form (e.g., reports by agencies and contractors), as magnetic tapes (e.g., Census Summary Tapes), through private sector database services (e.g., ERIC data), and even through online database services operated by the government itself (e.g., MEDLINE).

The complexity of the government's activity as provider/vendor makes it difficult to generalize about what the "role of government" should be. Advocates of an active government information role argue that:

- Important information needs not served by the marketplace should be met by government;
- When information has been generated or collected using taxpayer funds, it should be openly and equitably available to the general public;
- Government has a legitimate role in developing information resources for dealing with societal problems;
- To participate fully in our democratic society, citizens must be informed and aware, regardless of their ability to pay for needed information (35).

Advocates of restricting the role of government and placing maximum reliance on the private sector argue that:

- Our political economy is based on the view that individual freedom and initiative, expressed through competitive private enterprise, are the best means of supplying the products and services needed in society;
- Multiple private sources of information assure that a diversity of views are expressed, and customize information to allow it to penetrate many different "cognitive screens" (e.g., an item of research news will be presented in different ways to scientists, engineers, managers, customers, etc.);
- The private sector can widen the distribution of information from government, as well as from private sources;
- Government intervention in the information marketplace interferes with the ability of the market mechanism to allocate resources for the optimal production of goods and services;
- Government entry into the marketplace can have a chilling effect on private sector information generation, collection and distribution. (36).

The information industry has attempted to strike a balance between these considerations, arguing that there should be an ongoing presumption in favor of the private sector, rebuttable in appropriate situations. In this view, when a critical need arises for an information product or service not provided by the private sector, the government should take the following steps in order of priority: encourage the private sector to meet the need, provide inducements to the private sector to meet the need, or contract out to the private sector. When the government does provide an information product, the product's price should generally reflect the full costs incurred in the development, production and dissemination of the product (37).

The Reagan Administration's philosophy generally favors the industry viewpoint, but as noted above, there is a possibility that budget pressures caused by the federal deficit will lead government agencies to develop or step up cost recovery programs through direct sales of information products. As technology lessens the distinctions between creation, enhancement and

distribution of information, it will become technologically much easier for government agencies to market their own enhanced information products. The public might support this kind of "government entrepreneurship" as providing equivalent service at less cost.

Another potential pressure toward a larger government provider/vendor role is the problem of exclusivity vs. public access. As information becomes more important for competitive success, it will be kept more closely. Put another way, exclusivity is what makes information valuable in the commercial marketplace. For much of scientific, political and cultural life, however, free or inexpensive access to information is essential for progress. Thus the growing tendency to commercialize information and hold it more closely could bring forth a counter-movement to increase government's role in assuring easy public access to information deemed essential for scientific and cultural progress, citizen participation, and dealing with societal problems.

2. Acting As An Information User/Customer

Important issues of efficiency and competition with the private sector also arise in government's role as an information user. One example of a "government as user" issue important for the information industry is situations where federal agencies provide data processing services for each other. A recent Office of Management and Budget (OMB) circular encourages this sort of activity so as to promote the full and efficient use of government-owned or leased computers. At the same time, the circular calls for compensation for such services rendered, so that computer center managers cannot inflate the purported requirements of their own agencies and thus use only true spare capacity. Another motivation is that government centers not enter into unfair competition with private data processing firms which must, of course, charge prices sufficient to cover all costs and pay taxes.

3. Acting As A Regulator

Many government activities discussed in this section related to privacy and copyright protection are examples of government acting as a regulator and guarantor of rights. But government regulatory activities in the information sector of the economy extend far beyond the examples reviewed in this report.

One regulatory area of great importance to the information industry is related to the development of "intelligent networks" between now and the year 2000. Intelligent networks are able to do what is called "protocol conversion," which allows them to compensate for the differences and disparities in data formats. Which companies can offer protocol conversion, and on what terms, remains an unresolved question.

At the moment, protocol conversion is typically performed by a value-added packet switched carrier on a competitive, unregulated basis, although Regional Bell Operating Companies (RBOC's) are permitted to offer such services in one particular instance. The Federal Communications Commission staff has proposed that all telecommunications carriers, including the RBOC's, offer protocol conversion under tariff -- that is, a regulated government price schedule. Alongside this domestic policy debate is a parallel proceeding in the International Telecommunications Union, a specialized body in the United Nations system. The 1988 World Administrative Telephone and Telegraph Conference will establish the international terms and conditions of transmission, data processing, and database service offerings for many years to come. A number of foreign telecommunications administrations are known to favor extending regulation to intelligent network functions, much as the FCC staff has proposed. These developments could have a major impact on the industry and require creative policy development.

4. Acting As A Goal-Setter

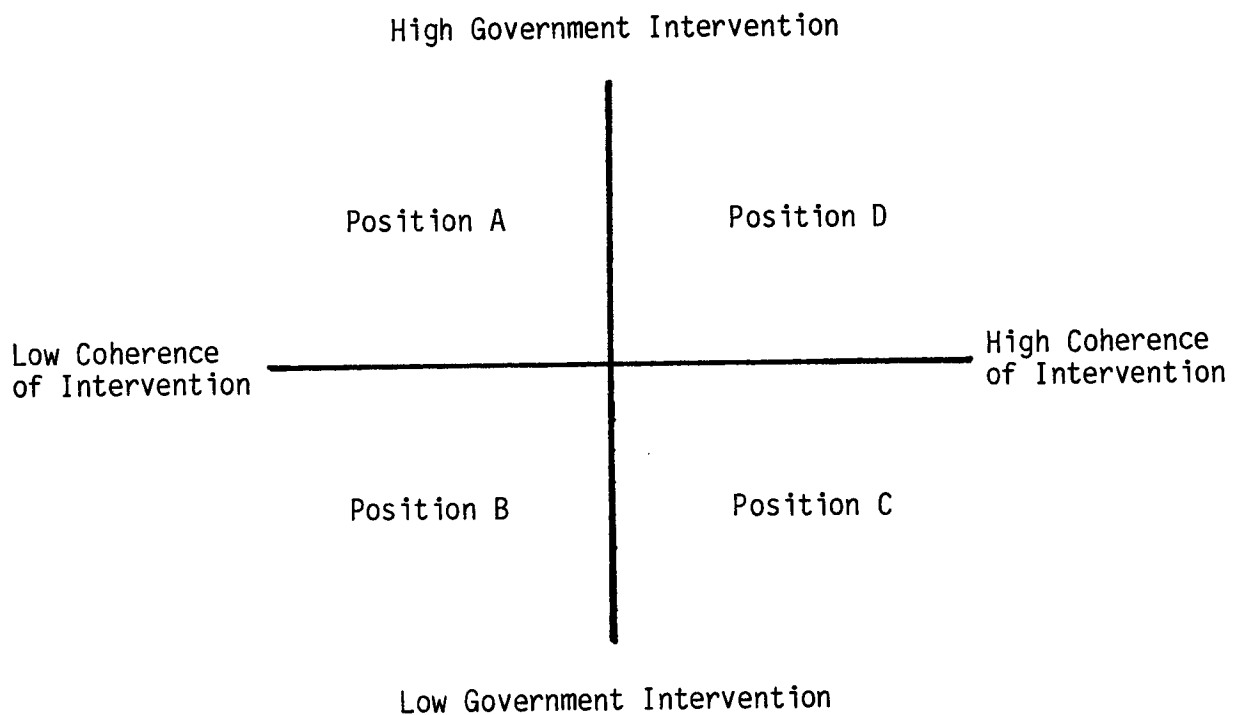
A final broad role for government is goal-setting and foresight. One aspect of this role is R&D stimulation and coordination. There has been much discussion of Japanese efforts, through the Ministry of International Trade and Industry (MITI) and other agencies, to gain a national competitive edge in new technical areas such as fifth generation computers (38). This kind of R&D stimulation and coordination is not unknown in the United States, but it is often done in a back-door way. As Lester Thurow points out, "The U. S. Defense Department has often played the role of Japan's MITI. For instance, the Department is financing a fifth generation computer project and a very large scale integrated semiconductor project to match those of the Japanese" (39).

Government goal-setting can take even more interventionist forms. For example, the Japanese are developing what they call the "technopolis strategy," making major commitments to the development of high-tech towns that will be proving grounds for business and public utilization of state-of-the-art information technologies (40). The French government, responding to the Nora-Minc report, set goals for the computerization of French society and, in pursuit of those goals, pioneered the MINITEL system. MINITEL illustrates how clear government goals can speed change: nearly three million subscribers already have access to more than 1,200 different data bases, banking and financial services, press hookups, and educational and cultural channels. MINITEL may also illustrate the dangers of a highly interventionist approach: it is underutilized, expensive to maintain, and rapidly becoming technologically obsolete.

Government can play a larger role in goal setting and foresight without requiring greater government intervention in the information marketplace.

Figure 5-1 contrasts different levels of government intervention and different degrees of coherence of government goals and policies. Position A, "high government intervention/low coherence of intervention", is probably a fair characterization of the information policy arena over much of the past generation. With increasing deregulation, we are moving somewhat closer to position B, an emphasis on minimizing intervention. Many European governments and some advocates of a comprehensive "national information policy" favor position D, high government intervention/high coherence of intervention. In recent years, information policy debates have often been "A vs. B" debates about the proper level of government intervention.

Figure 5-1: Strategies of Government Intervention



Source: Institute for Alternative Futures

Position C, low intervention/high coherence of intervention, is relatively unfamiliar in economics and information policy. Conventional liberals tend to see this position as conservative, because it is highly market-oriented. Conventional conservatives tend to see this position as liberal because of its major focus on the coherence of government policy.

Position C might also include government encouragement of "smarter" markets. In the information society, Adam Smith's dictum - that increases in producer power should be offset by consumer power - can be put into effect. The government would watch for and reinforce consumer group activity that could provide sophisticated monitoring of products and services. Intelligent networks with community bulletin boards are the precursors of national consumer evaluation networks whose scope will be far greater than today's Consumer Reports. These networks would not remove the need for government regulation altogether. For example, the FDA will always need to be the ultimate insurer of the quality of the prescription drug system. But smart markets with intelligent consumer networks would significantly improve the quality of the drug surveillance system.

It is possible that the government's role in goal-setting and foresight will need to increase between now and the year 2000 to help the U.S. meet the challenge of international competition and to help shape the social impacts of the information revolution. If so, position C, a low intervention/high coherence of intervention policy strategy, will merit attention. Such a strategy becomes feasible to the extent that a widely shared strategic vision emerges of a preferred future for the information society.

INTELLECTUAL PROPERTY RIGHTS

Copyrights and other forms of intellectual property protection such as patents, trademarks and trade secrets are not universal concepts. They have no close counterparts in early civilizations or even in some contemporary cultures where products of intellectual creation are felt to belong to the community-at-large and not to their creators (41). Certain technological and social conditions appear to be necessary for these legal concepts of intellectual property protection to come into existence. Intellectual property rights represent a bargain struck between the public and authors and publishers to ensure that creators and providers of information are rewarded and that society has an expanding base of information available. Technological change periodically forces us to reexamine the nature of this bargain.

Technological change has in fact been the most critical factor in the emergence and evolution of the concepts related to intellectual property rights. Indeed, it was the invention of printing that created the need for intellectual property protection. This breakthrough in copying technology caused authors to lose control of the profits generated from their writing, and it also caused inventors who went from town to town selling their intellectual wares to lose control of the dissemination of their ideas (42).

Intellectual property concepts have been central elements in market economies since the Statute of Anne was enacted in England in 1709. Our nation's founders went beyond the British model, asserting the revolutionary notion that intellectual property rights belong to the author, rather than to the King or government, and that these rights should be protected by the government. They adopted a Constitutional clause empowering Congress "To Promote the Progress of Sciences and Useful Arts, by Securing for limited Times to Authors and Inventors the Exclusive Right to their respective

Writings and Discoveries." They believed that intellectual property rights would simultaneously serve the interests of authors and creators and the interest of society to encourage the creation and dissemination of knowledge.

Defining intellectual products as "property" provided incentives for creation and supported a great flourishing of creative, technological, and scientific works. But the basic concepts of property were originally formulated to deal with tangibles such as land and chattels. Property is essentially the right to exclude others from possession and use. It has become increasingly clear over time that some of the characteristics of information and intellectual creation make the definition and enforcement of property rights difficult. For example, information can be sold or given away, yet retained by the original owner. Unlike a solid object, it takes effort to keep information from diffusing or leaking, and the more it leaks the more people have it. It can be used repeatedly without wearing out or being used up; and while it can go stale, it often improves and expands as it is used. Vast amounts of it can be transported inexpensively at the speed of light. While it has to be transported by some kind of carrier (radio signal, book, tape), its value is independent of the value of the carrier (43). There have been efforts to establish units or procedures for measuring the value or quantity of pure information separate from any marker or carrier, but there is no widely agreed upon standard.

Despite these "peculiar characteristics," treating information and intellectual creation as property has worked well over the past 200 years. But now, technological changes are underway that are arguably as profound as the invention of printing itself. Traditional intellectual property protections designed for the technology of mechanical print are being strained by the emergence of digital electronic technologies with very different

technical characteristics and forms of use (see Table 5-1). In this new electronic environment, the "peculiar characteristics" that arise in treating information as property are becoming more important, creating major problems of intellectual property protection.

Table 5-1: Contrast of Mechanical Print and Digital Electronic Technologies

Technical characteristics of works	Uses of works	Technical characteristics of works	Uses of works
Mechanical print Produced in tangible "units" (but requires expensive machines and special skills to copy in large quantities)	Publishers, printers, and booksellers cooperate to publish work and sell units to individuals or libraries; authors received per-copy royalty on first sale of a copy; copyright holder retains rights to <i>print and publish "the work"</i>	Digital electronic Simultaneously available	Many individuals may access a central store of works, a "data base"
Fixed in tangible copies (one "canonical" form of "the work" exists)	Individuals read; scholars quote or cite; owner of a <i>copy</i> may copy parts of it by hand, or sell, rent, or destroy <i>his copy</i>	Reproducible at very low cost	Prices for magnetic and optical storage media will continue to fall; media are <i>very high in capacity</i> , and <i>very fast in making reproductions</i> ; perfect copies <i>can be made from copies</i>
Analog electronic print "Originals" sold in tangible copies	E.g., audio recordings and videocassettes are initially manufactured and sold somewhat like traditional, mechanically printed books	Versatile	Many types of works (e.g., text, music, video-taped or filmed pictures) may be stored and communicated digitally
Reproducible at moderate cost (e.g., xerographic copies; audio and video tapes)	Small works, or parts of large works, are often copied privately by users <i>with machines</i> , rather than by hand; <i>copies of copies</i> are poorer in quality than <i>copies of originals</i>	Decentralized and pervasive	Highly capable machines are becoming ubiquitous in homes and offices
Decentralized	Many individuals have equipment and skills to make copies	Interconnected	Machines may be privately linked by switched telephone circuits: works can be transferred with impunity; and joint authorship is not restricted by the physical separation of the authors
Technology-bounded	Different media and equipment usually needed to use and copy different types of works	Dynamic	Work may be interactive or constantly evolving; one "canonical" copy may not exist
Analog electronic broadcast Simultaneously available (one "intangible copy")	Advertisers may pay for work to attract potential customers to their product; alternatively, users may pay (e.g., public broadcasting; subscription television)	Processible	Machines may be programmed to transform and manipulate works, perhaps masking evidence of original authorship
		Autonomous	Works may be <i>functional</i> , rather than only <i>meaningful</i> , as are traditional copyrightable works

Source: Property Rights in an Age of Electronics and Information. (Washington, D.C.: Office of Technology Assessment, 1986), Table 1-1 on Characteristics of Information Technologies and Uses of Intellectual Property, p. 24.

Different Views of the Intellectual Property Issue

While it is widely understood that technological changes are posing problems for intellectual property protection, there are major disagreements about the magnitude of these problems and what to do about them.

Some believe that adapting to technological change only requires revisions at the margins of intellectual property law. In this view, changes can be dealt with incrementally through judicial accommodation and amendments to existing laws.

Others believe that technological change will have much larger impacts on intellectual property law, forcing major revisions of existing legislation and the development of new legislation that stands apart from existing law. The Semiconductor Chip Protection Act is an example of new legislation specially formulated to extend the principles of intellectual property into a new technological context.

Still others believe that recent and emerging technological changes are so revolutionary that they will cause what Harlan Cleveland calls "a nervous breakdown of copyright protection," (44) which will require a fundamental rethinking of our basic concepts of intellectual property:

The openness which the informatization of society brings in its train is raising fundamental questions about the idea that knowledge 'belongs' to a person or an organization. Like waves eating away the foundations of a seashore hotel, the propensity of this 'sharing resource' to leak is eroding the doctrine that knowledge can be owned, exchanged, and monopolized the way 'real' resources can. Those who persist in treating their knowledge as property are apt, like King Canute, to get wet (45).

In this view, revisions of the law based on wholly new principles, and new legal options that dispense with traditional ideas of intellectual property may prove necessary. The 1985 report by The President's Commission on Industrial Competitiveness sets out this perspective:

Although the application of our intellectual property rules has been adjusted over time in response to changing commercial practice and evolving technologies, the continuing stream of the new scientific advances calls for rethinking the very concepts derived from earlier centuries on which those rules are based. New concepts of what intellectual property is and how it

should be protected -- beyond patents, trademarks, trade secrets, and copyrights -- may well be needed, as well as sweeping changes in intellectual property laws and the ways they are administered and enforced (46).

The dominant view of most information industry executives is that while technological changes do require major adjustments, the underlying idea of copyright is just as valid today as it ever was -- perhaps even more so with the greatly increased importance of information.

Why Intellectual Property Rights Will Remain a Prominent Issue

The number of important problems involved in intellectual property rights is so large that this issue is certain to be important between now and the end of the century. Below is a sampling of these:

Changing stakeholders: New information technologies are changing the roles and numbers of stakeholders and diffusing the focus on intellectual property protection. For example, authors, publishers, film makers and other copyright holders are concerned that new copying and recording technologies will undermine their ability to enforce their copyrights, and they typically want stronger enforcement measures. But database producers, information analysts, and others who custom-package existing information often oppose tighter restrictions on the use and reuse of copyrighted material and want to receive greater financial return for their value-added. Manufacturers of copying and recording equipment oppose any measures that would make their products less useful to buyers or more expensive. Many educators favor arrangements that would let them use copyrighted materials at reduced rates or even exempt educational uses from the law. Developing nations championing a New World Information Order want industrialized countries to relax intellectual property protection so that poor countries can more easily afford

to make use of new information products and services. And meanwhile, the general public is becoming increasingly accustomed to copying materials of all kinds for private use. Most of these stakeholders do not have a strong concern for the protection of intellectual property (47).

New kinds of works: The law of intellectual property is being strained by new kinds of functional works like computer operating codes and software programs, which "fall between the cracks" of the traditional distinction between patents for inventions and copyrights for writings. Permissions arrangements developed for a printed copy of a book may not be viable when the "copy" is a single optical disk with the text of hundreds of books and articles combined with sound, pictures, and full-motion video representing thousands of proprietary interests.

New Technology of Piracy: Technologies such as paper copiers, satellite antennas, audio tapes and videocassette recorders raise new problems of piracy and copyright infringement. These problems will get much worse by the year 2000. Writable and erasable optical disk storage will make it much cheaper to store large amounts of textual, musical, and visual material. Intellectual property will also be able to be communicated and transferred into storage much more quickly. For example, fiber optic technology now in the laboratory (and available for offices and homes by the year 2000) can transfer 100 average-length novels over a distance of 100 miles in 1 second (48).

New Technology of Manipulation: It will also be possible to manipulate information in very sophisticated ways using microcomputers as powerful as today's mainframes. This would allow, for example, the piracy of the contents of large commercial databases and a rapid sorting and reworking of the

information into forms so different that the compilers of the original databases would find it hard to prove that they had been pirated. Growing computer capabilities for the manipulation of visual images will also pose new problems. For example, an unscrupulous artist could use technology to distort or modify a well-known piece of art for his own profit without the consent of the original artist (49).

Problems of "Private Use": Copying information for "private use" posed no threat to industry profits in the past, and the law gives limited guidance about the extent to which private use should be considered an infringement of copyright. But as copying technologies become so widespread that they can have significant financial impacts, private use becomes an important issue. Should private use be restricted? If so, how can bans on private use possibly be enforced?

Problems of Electronic Databases: The legal status of electronic databases is another area of ambiguity. Databases are either full text, bibliographic, or numeric. The property rights for full text are the same as printed text. Bibliographic databases vary, depending on how substantial any abstracting is. Numeric databases are not copyrightable per se as simply data, rather than works of authorship. Copyright was developed to protect the expression of information, not information or facts per se. Because some machine-readable databases fall somewhere between information and expression, uncertainty remains about their ultimate copyright status (50). The legal status of machine-readable databases is also clouded by the difficulty or impossibility of meeting the traditional procedural requirements of registration and deposit for obtaining copyrights from the U.S. Copyright Office. To fully benefit from existing copyright law, publishers have had to redeposit all or part of a database each time it is updated, even if it is

modified on a daily basis. New, less burdensome registration procedures are already under review (51).

"Fair use" and "derivative use": Questions relating to the "fair use" and "derivative use" of electronic databases will prove harder to resolve than copyright registration. According to statute, some uses of copyrighted materials are considered "fair use" (e.g., limited uses of primarily factual material by non-profit organizations with no significant effect on the value of the work used). As Boston information lawyer Peter Marx observes, "This [fair use] exemption is arguably the most imprecise concept in copyright law" (52). The courts have yet to apply the "fair use" doctrine to cases involving database copyright infringement, so the scope of this exemption remains uncertain. The "derivative use" of information is an increasingly important issue because a significant part of the growth of the information industry is based on the ability to use information technologies to create secondary information products, information customized to meet the requirements of specialized niche markets. Copyright holders on primary information resources want to maintain their right to benefit from all subsequent works based on their original work. But if copyright protection is interpreted too broadly, it could inhibit the production of secondary information products. The balance between protecting primary information products and allowing the production of secondary products is yet to be determined (53).

Unfair Competition Protection: The information industry is a value-added industry. Important aspects of added value such as combining information creatively from different sources, or providing indexing for searching information, may not be subject to copyright protection as works of "authorship." Lack of copyright protection in such areas could have a

dampening effect on industry activities. However, some historical precedent does exist for using fair competition standards in situations where copyright does not apply, and this is a strategy the information industry is likely to pursue.

Software Projection: A fairly long time scale for sorting out the issues in database protection can be expected, as may be seen by comparison with the history of software protection. In the mid-1960's, software writers began submitting materials to the Copyright Office for examination in the expectation of obtaining certificates of registration (such certificates have the value of establishing a presumption of validity of copyright in litigation). Operating under its normal practice of accepting submissions in cases of doubt, The Office in 1965 announced that it would accept printouts and issue certificates. Conversely, the Patent and Trademark Office resolutely took the position, through three Supreme Court cases in the 1970's and early 1980's, that software was not patentable, until the Court finally resolved the matter by holding that patent rights could inhere in software if it served as an integral part of an industrial process.

Meanwhile, Congress did not pass an omnibus copyright revision bill until 1976, even though the Copyright Office had commenced a series of special studies in support of the revision effort twenty years earlier. Unable to decide what to do about software, Congress put a placeholder "grandfather" clause in the revision bill, having separately created a national commission to study the issue and make a recommendation. In 1978 the commission recommended an amendment to include software explicitly under the Copyright Act, and Congress followed that recommendation in 1980. Now, six years later, the case law on software has developed to the point that it has substantial content. Protection now covers not only machine-readable versions of software

but microcode as well; the logic and structure of a program, as well as lines of code as such; and the "look and feel" of a program's display, according the recent decisions yet to be tested on appeal. Just how far protection can go without creating rights more akin to patent - rejected for all but very limited cases - than copyright is not clear and will have to be defined ultimately by the courts.

"Collective electronic authorship": is an example of a more distant but potentially important problem. As communication through computer networks becomes common, the idea of granting copyrights to "original" works of "authorship" will have to be adapted to a new situation of "invisible colleges" of individuals from anywhere in the world collaborating in the creation of constantly changing intellectual products (54). The use of hypertext and massive storage to access and comment on virtually any piece of information will likewise raise authorship issues (55).

Copyright Issues When the Government is the Buyer: When government acts as a user of information technologies, products, and services, different issues can arise. Procurement practices provide a good example. Government can buy custom-built products, as for the military; standard off-the-shelf products, as for use in office word processing; or products specially designed but which build upon earlier commercial designs or products. Different proprietary rights arrangements may be appropriate in different cases. Numerous commentators have made the point that government should pay for and acquire only the rights it needs, leaving residual rights in software or other technical data for the original producers so as to permit subsequent value-added product development and marketing. Although the revised federal rights in data policies are still pending, Congress this year legislated that Department of Defense procurements would leave rights in privately funded

software and other technical data in contractors' hands, even if they were delivered to the government at some point. A similar issue arose when Florida revised its public records statute in 1985 to promote online access. The new law contains an exemption for proprietary software used or licensed by government agencies from the otherwise standard disclosure provisions.

Growing value of information: Information resources are growing in economic value as they become central to most of our activities. The tension that exists between the aim of temporarily restricting information to foster its creation and the aim of encouraging dissemination of information throughout society is increasing as information resources become more important and, in some forms, more expensive (56).

Restricted Access: In electronic publishing, control of access is often the primary means of protecting proprietary interests, but this conflicts with the interest of society to encourage the wide dissemination of information and knowledge. As Robert Kerr, President of the Alexandria Institute, puts it: "At a time when information technologies offer unprecedented economies of scale for the distribution of information, these same technologies and the intellectual property system require that control be exercised over access to assure proprietary protection. The result could be restricted access, which defeats a major purpose of intellectual property law." (57)

International Issues: International aspects of intellectual property protection will come to be an important issue. Without a sufficient degree of agreement on an international scale, individuals in certain other countries will continue to reproduce and sell intellectual works with impunity. From another perspective, people in Third World countries are frequently concerned with the costs imposed by current intellectual property arrangements. For

example, after satellite collected information useful for making agricultural decisions in developing countries has been analyzed and copyrighted by a commercial company, it may be priced too high for the those in developing countries to afford (58). Satellite technology also poses problems of unwanted reception (programming may be beamed at nations whose governments may not want it) and unpaid reception (nations adjacent to a broadcasting satellites' "electronic footprint" may intercept and unscramble the programming without paying the fees charged by the broadcaster) (59).

Finding The Balance

Taken together, these emerging problems and issues pose a severe challenge to the existing system of intellectual property protection. Current law, applied in the context of emerging information technologies, fails in many cases to provide adequate compensation to authors and publishers, while presenting growing obstacles to the goal of assuring maximum access to information for society as a whole. This is the conclusion reached in the recent assessment of Intellectual Property Rights in an Age of Electronics and Information by the Office of Technology Assessment:

Intellectual property law is increasingly outdated in providing appropriate incentives for the production and distribution of many information-based goods. Because of this, markets may increasingly fail to provide economically and socially efficient varieties of information (60).

Different problems will require different degrees of change done on different time scales. For example, easing the burden of copywriting dynamic databases calls for relatively small changes in copyright registration and deposit regulations which can be accomplished in a short period of time. Protecting computer programs will require larger legal changes, and these

changes require immediate attention. New technical capabilities for copying, transmitting and manipulating factual information may require sweeping legal revisions. But premature, poorly thought through changes could dampen competition in the industry, stifle innovation, or restrict access to information. Other problems, like collective electronic authorship, may not need to be dealt with until the later 1990's.

Acting with foresight to get ahead of intellectual property problems is a critical challenge for the information industry. Failure to think through responses to problems before they become critical could entail severe economic penalties.

Potential Strategies for Intellectual Property Rights Protection

There are several distinct strategies that can be used in attempting to resolve the copyright issue. It is important to recall that copyright laws represent an "intellectual property bargain" between individual creators and the public. "In exchange for granting authors and inventors exclusive rights in their writings and inventions, the American public is to benefit from the disclosure of inventions, the publication of writings, and the eventual return of both to the public domain. The purpose of copyright, in particular, is to benefit the public by encouraging learning through the dissemination of works" (61). The copyright issue is likely to remain troublesome despite the 1976 revision of the Copyright law, because of rapidly changing technologies. Solutions are difficult because of the wide variety of intellectual works (eg. books, movies, electronically communicated data bases). And no single solution may be possible.

Below we summarize potential strategies available for dealing with the intellectual property rights issue. These strategies are drawn from several

sources, most importantly from the OTA report on Intellectual Property Protection in an Age of Electronics and Information (62).

1. Rely on the marketplace - private entrepreneurs, acting as groups or individuals, develop codes, standards, marketplace culture and technological fixes (e.g., electronically embedded identifiers which could indicate inappropriate use). In a survey for the OTA study, 54 percent of the public favored this approach. Much will be done in the marketplace anyway as businesses adjust to the market. However this approach does not give legal recourse to abuses by third parties and could lead some information providers to limit access that they previously had an incentive to keep open.

2. Judicial Accommodation - leaving copyright protection to the courts is appropriate to the extent that decisions can be made on the basis of existing law. In areas of rapid technological change, however, obsolescence in the law and lack of technical expertise in the courts make judicial accommodation more difficult. Recently, for example, the Supreme Court has shown considerable deference to Congress in copyright law, especially when new legislation was pending.

3. Amend the Copyright statutes - this may be appropriate for relatively narrow issues, but does not address the fact that the fundamental difficulties posed by technological advance are at the conceptual core of the problem with existing law.

4. "Sui Generis" Legislation - legislation such as the Semiconductor Chip Protection Act can be used to deal with technologies or issues that stand apart, in a class of their own. This approach has also been suggested for computer programs. While this is appropriate for specific identifiable

technologies, it creates exceptions to the general policies, and expends political investments on narrow issues.

5. Revision of the Copyright Act - Many feel that the Copyright Act of 1976 is adequate for the foreseeable future, yet there are substantial and worsening enforcement problems, and the law is becoming irrelevant to some new technologies. It is likely that Congress will need to address the issue in the 1990's. The OTA report suggests the next revision protect differently works of art, fact, and function. Works of art, whose value is loosely tied to expression, might be protected in the tradition copyright fashion. Works of fact, whose value lies in the accurate representation of reality, might be tailored to reflect this value, while at the same time assuring adequate public access to socially and politically important information. Works of function, which rely on algorithms as their source of value, might be protected along lines of patent law, with some threshold requirements of advance over prior art and disclosure of the work. Traditional limitations on rights, such as fair use, would be adjusted to the three part distinction of art, fact or function. The political difficulty of mounting a revision that departs substantially from existing law, international uncertainty, and ever present enforcement difficulties are among the drawbacks for an omnibus revision.

6. Alternatives to Copyright and Patent: A Distributive Approach - This approach would jettison traditional intellectual property protections and focus on desired outcomes. For example it might specify an outcome in terms of recovery of fixed costs plus value added plus rents limited to a certain rate of return. Works would enter the public domain after the rate of return objectives were met. This approach has advantages of assured financial return, but it requires information about information markets that is not now

available, and would require very large government intervention in the marketplace.

7. Restricting access - Controlling access to works and access to the networks through which they can be obtained is a growing alternative to legal property protection. Since much of the value of competitive business information is its exclusivity, this is now a fairly common practice. Yet potential disadvantages include causing information to be less widely available and, given the concentration likely in the information industry, the ability to control prices more easily.

An option not focused on directly in the OTA report, but which has been proposed in light of the massive storage opportunities provided by CD-ROM and related technologies, should be on the list:

9. Pay-per-use - This option, proposed by the Alexandria Institute, is based on the notion that "publishing" will change significantly in importance as CD-ROM based mass storage increases. Publishers and authors would approve the inclusion of their works along with thousands of others on optical disks for use in closed access systems. Acquirers of the CD-ROM disks would pay very little for the disks but then access information on a graduated "pay-per-use" basis such as: so much for an abstract, more for electronic viewing of the full text, and more yet for page or electronic copies. The access equipment would record what materials are used and payments due to authors and publishers. Alexandria Institute's proposal is aimed at simultaneously protecting proprietary rights and providing widespread public access to a broad body of knowledge (63). Every local library (and every business library) would have access to nearly the equivalent of the Library of Congress. Access could be assured, and the feeling of the "free public

library" could remain. Each user of the library could have access to a certain dollar amount worth of information each year. Libraries could adjust their budgets to a pay-per-use format. Instead of paying for acquisition regardless of use, their acquisition costs would be low, with the difference going into use charges.

Pathways into the future will include various combinations of these strategies. The challenge between now and 2000 is to find an appropriate balance that projects the rights of authors and publishers and also assures that the whole society can progress toward enhanced information access. The scenarios in Section 6 lay out four pathways which vary depending on the depth of the perceived problem in the copyright area, the degree of revision of the statute, the aggressiveness of vendors and users in developing non-legislative solutions, and the adjustment to new technologies such as CD-ROM.

INFORMATION LITERACY

Different Views of Information Literacy

Information literacy has two important policy dimensions. The first is what this literacy could do to enable us individually and as a society to be productive and creative -- to make the best use of "the ultimate resource," ourselves. The second important policy dimension is the prospect for enhancing or retarding equity in society.

The term "information literacy" has begun to come into common use, but it has no agreed-upon meaning (64). It is often used synonymously with the term "computer literacy." Building on the thinking of computer pioneer Alan Kay, one of the creative pioneers of the information field, we draw a distinction here between two levels of literacy which we call "basic information literacy" and "creative information literacy." Neither of these types of literacy is yet widespread in our society.

Basic information literacy involves knowing how to use available technologies, from a card catalog to an electronic database, to access information effectively. Today it includes skills usually described by the term "computer literacy," because these skills are increasingly essential for getting along in daily life. As Alan Kay puts it: "Integrated programs for word processing, graphics, simulation, information retrieval and person-to-person communication will be the pencil and paper of the near future" (65).

Creative information literacy is a level of fluency high enough to be a springboard for personal creativity. Information literacy in this sense includes not only how to search out information, but how to use information in creative thinking and problem solving. It is understanding how information can enhance one's life (e.g., new possibilities for learning, managing a small business, interacting with other people) as well as understanding possible dangers related to information (e.g., privacy, ergonomics, placing too much

faith in computer models). This is the level of literacy that Alan Kay urges us all to move toward in our use of computers:

Computer literacy is a contact with the activity of computing deep enough to make the computational equivalent of reading and writing fluent and enjoyable. As in all the arts, a romance with the material must be well underway...

Any medium powerful enough to extend man's reach is powerful enough to topple his world. To get the medium's magic to work for one's aims rather than against them is to attain literacy (66).

Beyond these two senses of information literacy, some foresee the possibility that emerging information technologies may alter our very patterns of thought and extend our mental capabilities. For example, Benjamin M. Compaine of the Harvard Program on Information Resources Policy speculates about the possible emergence of a "New Literacy" that would involve "a shift in perceptions...as fundamental as the shift from oral to written records was as the basis for traditional literacy" (67).

The issue of information literacy also has an equity dimension. However information literacy is defined, will there be a growing "information gap" between the information "Haves" and "Have Nots," the "Knows" and the "Know Nots," the "Can Do" and "Can Do Nots?"

Why Information Literacy Will Be A Prominent Issue In The Year 2000

There are two key reasons to believe information literacy will become an increasingly prominent issue between now and the year 2000.

First, we need greater information literacy to cope successfully with the challenges facing our society. Arms control and peacekeeping, population, food, development, ecology, climate, energy and resources, racial harmony, changing gender roles, meeting the needs of an aging society, revitalizing

community life, and developing more opportunities for productive, rewarding work -- all these challenges cry out for greater creativity, better problem solving and more informed action. And that is what information literacy in the broader, creative sense is all about. That is what the Information Millennium can ultimately be about: not machines, but what human beings can do when empowered by knowledge and wisdom.

Second, the issue of a gap between the information "Haves" and "Have Nots" is already surfacing, and under certain circumstances it could become a significant issue. The idea of an "information gap" is plausible in historical terms. As Benjamin Compaine points out, major new innovations like electrification, the automobile and the telephone do indeed start with "a small vanguard of adopters who tend to be better off economically than the population at large" (68). Even if the innovations soon diffuse throughout society, there is a time period during which commercial interests and the well-to-do are especially advantaged. The time between now and the year 2000 will probably be such a time for information technology. Yet the significance of this gap is as part of larger inequities in society. Since the mid-1970's the rich and the poor have increased while the middle has lost ground. General societal inequalities are likely to increase as this trend persists in the decades ahead (69).

Forces Shaping Information Literacy

The different aspects of "information literacy" set out above need to be considered separately in terms of the challenge they present to the information industry and society.

Most expressions of alarm about a "gap" in information literacy are directed at simple computer literacy, the "pencil and paper" skills for using microcomputers. A growing gap of this kind is possible. But the problem

should be kept in perspective. It is, unfortunately, only a new wrinkle on a tragic literacy gap that already exists: over five million adults are illiterate, and as many as ten million adults lack the skills of a competent 4th grade student (70). It is this larger literacy gap that requires urgent action. Information technology improves access to information but the information itself is usually available in other, less expensive forms -- for those who can read. It is the illiterate who are truly disenfranchised.

Computer literacy at the level that Alan Kay defines -- the ability to "get the medium's magic to work for one's aims rather than against them" -- presents us with another kind of "gap." An enormously powerful new technology is emerging, but we often use it inappropriately, without true fluency, and so fail to take advantage of what it could do.

In education, for example, Kay cautions that "we should not predict or expect that the personal computer will foster a new revolution in education just because it could" (71). As computers move into the classroom, there is a danger that the drill and practice part of the curriculum will be overemphasized, since it is easy to program. If this happens, learning would increasingly focus on addition and subtraction, spelling and punctuation, and dates and places rather than on ideas and meanings.

Branch and test programs, best exemplified by Control Data's PLATO system, are powerful teaching tools, but unless they are used in imaginative ways they tend to encourage rote learning of knowledge organized in static patterns. Alan Kay describes the development of PLATO at the University of Illinois where "20,000 students were manipulated by teachers' programs, some good, some bad," while "50 people could author (the programs), and they learned so much it made it all worthwhile." He concludes that "anything that doesn't allow the user to create isn't right" (72).

Simulations are among the most powerful computer tools for education. But simulations also have dangers. Kay warns that "the computer user has a strong motivation to emphasize the similarity between simulation and experience and to ignore the great distances that symbols interpose between models and the real world" (73). For example, the social consequences of decisions are usually left out of simulations because they are difficult to quantify.

These cautions about simulations also apply, outside of education, to decision support systems in business and government. Kay warns:

...(especially) serious is the human propensity to place faith in and assign higher powers to an agency that is not completely understood. The fact that many organizations actually base their decisions on -- worse, take their decisions from -- computer models is profoundly disturbing given the current state of the computer art (74).

In their recent book Mind Over Machine, Hubert and Stuart Dreyfus urge the same caution for expert systems in general -- which they would prefer us to call "competent systems" to help us remember that the highest reaches of expertise involve aspects of creativity, imagination, intuition, pattern recognition of meaningful wholes, and moral responsibility which no AI system can provide. "Those who are most acutely aware of the limitations of expert systems are best able to exploit their real capabilities" (75).

"To get the medium's magic to work for one's aims rather than against them" is a far greater challenge to the information industry and our society than getting computers into schools. It is a challenge that calls for encouraging responsible applications of information technology by avoiding hype and exaggeration and by stressing the limitations and potential abuses of information technology as part of what we mean by "computer literacy." And it is a challenge that calls for reaching out toward more creative uses of

information technology, uses that engage our full capacities and let us create.

Information literacy in the sense of knowledge about how to seek out knowledge and apply it in creative problem solving involves another kind of "information gap." Paul Zurkowski, President of the Information Industry Association, believes this is the crucial gap -- and opportunity -- confronting society and the information industry.

In the 1880's, a major knowledge activity vacuum existed. There were no child labor laws; children worked in the mills at age 13 and 14 for 15-16 hours a day. Women were chattels, deprived of development opportunity. There was no woman's suffrage. Scientific publishing in this country was limited. We relied on the German scientific publishers until after the First World War. Universities were closer to being divinity schools than institutions of higher scientific learning. Vast numbers of non-English-speaking immigrants were coming into the country... There were no modern communications beyond the telegraph system. It was a horse and buggy age.... (76)

Paul Zurkowski contrasts this knowledge activity vacuum of the 1880's with the situation in our society today:

Today we face a similar vacuum. Today, however, it is a creativity vacuum. In comparison to what is possible today the average person is proportionately worse off than 100 years ago. Tremendous information resources exist to stimulate creativity, yet the average person knows nothing about them.

It is a vacuum caused by a failure to take charge of the information revolution, to manage it for the benefit of all (77).

How might we fill this vacuum and "take charge of the information revolution"? Paul Zurkowski lays down a challenge to the information industry itself. Looking back at the knowledge activity vacuum of the 1880's, he suggests that Andrew Carnegie's free public library initiative proved an

enormous stimulus to our nation's development and utilization of information resources. "During the First World War, these libraries became known as the arsenals of democracy. Since then the free public library has... laid the foundation for today's information revolution" (78). What initiatives could we take today, he asks, that would have a social impact comparable to Andrew Carnegie's impact in the 1880's? What do we need to do to harness the vast energies being released by the information revolution?

The goal is an open marketplace of ideas in which the whole populace participates. To get there requires interim steps that could be facilitated by a worldwide movement led by librarians, archivists, information scientists, and information executives. Taking charge of the information revolution could be called Carnegie II: The Knowledge Enterprise.

First, we need to extend literacy skills so that every citizen is as information literate as the best of today's librarians. Second, with such a literate and knowledgeable citizenry we need to do everything we can to stimulate creativity, to enrich the knowledge society. Third, with more and more of the citizenry dependent on knowledge work as a way of producing wealth, we need to sustain the economics of information exchange (79).

Helping our society to move into a new era of creative information literacy is as large a challenge as any industry has ever faced. How well it is met will influence the shape of the future.

A final, more speculative aspect of information literacy also deserves attention. Historians, anthropologists, sociologists, linguists, psychologists and philosophers have been fascinated over the years by the fundamental changes in patterns of thought that tend to go along with the shift from oral literacy to a literacy that emphasizes reading and writing skills. Some of the impacts that have been associated with the invention of writing include:

- a stage of logical thinking not possible in cultures with only an oral tradition;
- enormous improvement in learning and teaching specialized subjects;
- modification of sense of time; historical inquiry becomes possible;
- increased explicitness of language;
- reduced emphasis on literal memorization;
- new self-conceptions and roles as part of the more complex social structures (civilization) that writing helped to make possible.

These changes accompanying the use of writing were amplified and others emerged with development of printing:

- changed conception of causality; causality as a logical, sequential sense of relationships;
- dramatic rise in the idea of the possibility of creativity and originality;
- sense of the private ownership of words;
- diversification of styles of writing beyond those that mimic oral style;
- new self-conception and roles as part of the more complex social structures (modern bureaucracy, corporations, nations) that printing helped to make possible (80).

Is it possible that new information technologies will eventually have as large an impact on human consciousness as the shift from oral to written literacy? No one really knows, but many speculations have been made.

Some speculations are disturbing. Theodore Roszak's recent book The Cult of Information warns that as information technology becomes more widespread, we might increasingly accept a "data processing model of thought" that would further alienate us from our intuitive, imaginative, creative capacities. The fatal oversight in this model of thought is that "it leaves out of account that aspect of thinking which makes it more an art than a

science, let alone a technology: the moment of inspiration, the mysterious origin of ideas" (81).

But if we do not make this mistake of underestimating ourselves, then how might a shift from the literacy of writing to the literacy of information technology effect our patterns of thought? Benjamin Compaine of Harvard University's Program on Information Resources Policy speculates that there could be "a fundamental innovation in conceptualizing and processing information." Assuming that we will successfully move ahead toward more interactive and creative ways of using information technology, he sets out the following possibilities:

- a return to skills of oral composition brought about by the development of voice recognition capabilities in computers;
- greater ability to think holistically and intuitively as well as logically and sequentially; skills for high level synthesis available to a much greater number; abilities to "see a whole from pieces";
- changed conception of causality; causality as complex, looping mutual causal processes;
- greater ability to organize, to find commonalities, to switch from detail to overview;
- patterns of thought that organize elements into a continuum of alternatives instead of either/or dichotomies;
- expansion of the concept of intelligence beyond linguistic and logical-mathematical intelligence to include more attention to spatial intelligence and possibly other aspects of intelligence such as bodily-kinesthetic, musical, and personal (82).

OTHER POLICY ISSUES

Other information policy issues that are already on the political agenda such as information liability, information security, and anti-trust are also likely to have lasting importance.

Globalization of the information society will bring international controversies to center stage in information policy (e.g., transborder data

flows, East-West trade, international copyright guarantees, enhancement of Third World development vs. cultural imperialism, global stock market regulation). By the year 2000 there will be a host of other issues, some impossible to anticipate.

Policy areas of the importance of those reviewed in this report will require the information industry to extend its foresight on the issues, joining in discussion with others. The challenge is to lead change rather than follow it.

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15. Meredith Mendes, p. 23.
16. Michael Schrage, "'Big Floyd' All Wired Up To Aid G-Men," Washington Post July 20, 1986, p. G1.
17. Ibid., p. G4.

18. Gary Marx, p. 44.
19. Electronic Surveillance and Civil Liberties, OTA-CIT-293. (Washington, D.C.: Office of Technology Assessment, U.S. Congress, October 1985), p. 4.
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21. Pete Earley, "Watching Me, Watching You," The Washington Post Magazine, May 11, 1986, pp. 9-11ff.
22. Peter J. Ognibene, "IRS Eyes," OMNI, (March 1985), p. 28.
23. Michael Schrage, "'Big Floyd' All Wired Up To Aid G-Men," The Washington Post, July 20, 1986, p. G1, G4.
24. Gary T. Marx, p. 45.
25. Pete Earley, p. 15.
26. OTA, Electronic Surveillance and Civil Liberties, p. 9. 1984 information was the most recent available when OTA published this report in October 1985.
27. Ibid., p. 4.
28. Robert R. Belair, "Information Privacy," chapter III in U.S. Department of Commerce, Issues In Information Policy, NTIA-SP-80-9. (Washington, D.C.: U.S. Government Printing Office, 1981), p. 42.
29. Public Policy Activities of the Information Industry Association. (Washington, D.C.: Information Industry Association, July 1986), p. 32.
30. In the telecommunications area, for example, most countries in Europe and the rest of the world have government-owned Postal Telephone & Telegraph (PTT) administrations which control telecommunications services. These PTTs are such large employers, are so heavily unionized, and contribute so much to government revenues that there is strong political resistance to the idea of turning them into competitive private companies. By contrast, in the United States telecommunications services are provided by private firms which are going through a dramatic process of deregulation. See "Telecommunications Liberalization" in Business Week, October 24, 1983, reprinted in Tom Forester, ed., The Information Technology Revolution (Cambridge, MA: MIT Press, 1985).
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46. Global Competition: The New Reality, The President's Commission on Industrial Competitiveness, January 1985; Appendix D, "A Special Report on the Protection of Intellectual Property Rights," p. 305.
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60. Ibid., p. 157.
61. Ibid., pp. 188-189.
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6: ALTERNATIVE FUTURES FOR THE INFORMATION BUSINESS

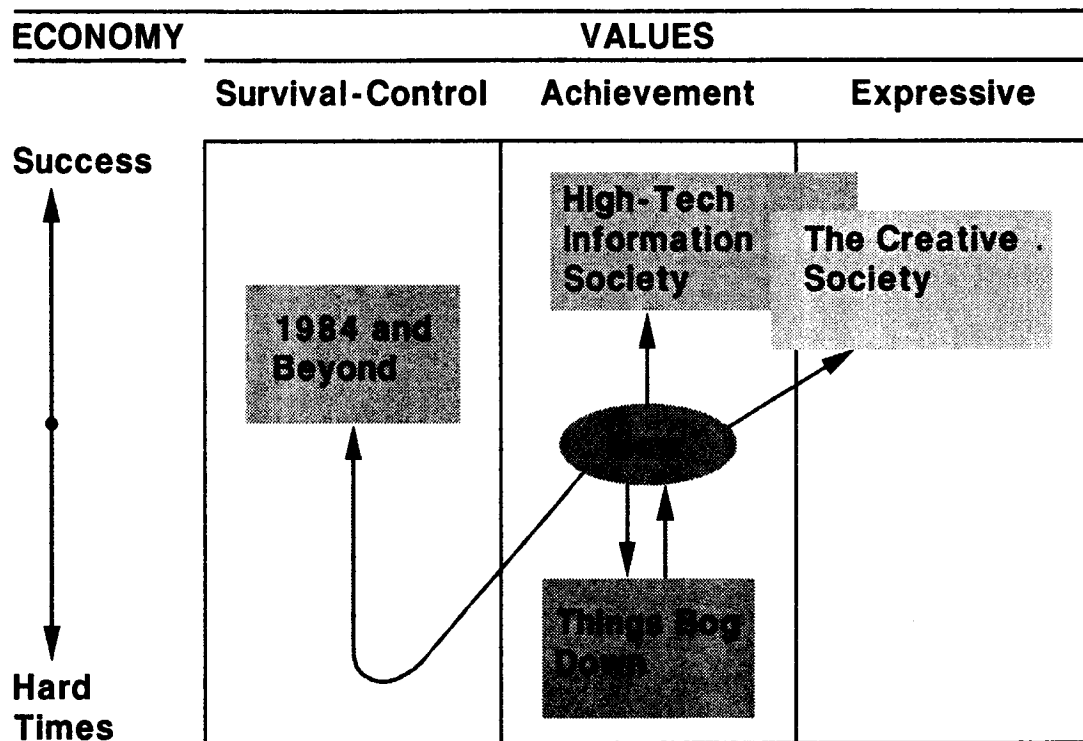
Sections 2 through 5 considered the future of information technology, its applications and changes in the information industry, societal impacts of the information revolution, and major information policy issues. This Section pulls all this information together into four alternative futures (1). Which future our society moves toward will be largely determined by what we do.

The High Tech Information Society is a variant of the highly optimistic, technologically-driven scenarios best described by the late futurist, Herman Kahn. A major information society image of this type of future is provided by Daniel Bell (2). The Creative Society is an optimistic scenario which assumes similar technologies but with applications that are driven by different values. It is focused much more on the potential of the information revolution to enhance creativity. As noted in Section 4, Alvin Toffler, Willis Harman, John Naisbitt, and other authors provide societal forecasts of this type (3). The Things Bog Down scenario is a moderate "bad news" scenario. It describes an unfortunately plausible path for the economy and the information industry to follow (4). The 1984 and Beyond scenario depicts a very undesirable future, but one in which the information revolution would play a major role (5).

Figure 6-1 illustrates the differing states of values and the economy in the four scenarios. Achievement values emphasize achievement motivation, material possessions and rewards, status recognition, growth, bigness, and competition. Expressive societally concerned values emphasize "personal best" (rather than winning over others), personal growth, cooperation, decentralization, harmony with nature, equal roles for men and women, membership in a single "global family," and concern for global problems, especially the plight of people in the poorest developing countries.

Survival-control values emphasize personal survival and security, order, social discipline, intolerance, and a weakening of traditional freedoms for the sake of social control.

Figure 6-1: Information Millennium Futures: Assumptions About Values and the Economy



Source: Institute for Alternative Futures

It is important to understand that these four scenarios are descriptions of fundamentally different futures. They are not just optimistic and pessimistic variations on a "base case," but instead are conceptually and structurally different images of the future. None of these images is designed to be a "most probable" future. Our purpose is to develop a small number of images that envelop or bound a broad range of future possibilities. Thinking in terms of a range of alternative futures can help business decision makers acknowledge uncertainty and clarify unexamined assumptions about "what

will be." Alternative images of the future allow decision makers to make more conscious choices about what they want the future to be like. They can highlight areas of risk and opportunity that more limited extrapolations would otherwise miss. They allow decision makers to think through which strategies should be pursued if future "A" materializes, if future "B" materializes, and so on. More importantly, they allow decision makers to explore "robust" strategies that appear beneficial across a wide range of alternative futures. They expand imagining capacity, creating new options for decision and action. They encourage awareness of the side effects and long-range consequences of decisions. They can be used to formulate a strategic vision, and they can provide a "common language" for communicating that vision throughout a company. Our hope is that these images will stimulate you to think more systematically about the kind of future you want to help create.

The following pages describe each scenario from the perspective of the year 2000 looking backwards. The scenarios are described by three different approaches. The first is a scenario overview, a single paragraph summary. The second is a more detailed and systematic description of each scenario. The third approach, in Table 6-1, is a matrix which compares and summarizes the scenarios.

THE HIGH-TECH INFORMATION SOCIETY

Scenario Overview

The High-Tech Information Society is driven by a booming economy, traditional American achievement values, and advanced information technologies which are rapidly incorporated into new products. This allows the information industry to grow at twice the rate of the GNP, rising to about 2 percent of sales across industry. Applications include full office automation, sophisticated simulations for training and decision support, and speech recognition and synthesis used for routine customer interaction. "AI agents" and "hypertext" devices automatically access and format information into its most appropriate form for the user. Privacy proves not to be a major problem. The role of government declines, particularly as a competitor in the marketplace. Basic information literacy is high. Copyright issues are resolved primarily in the marketplace, with little additional legislation or regulation.

Society and Economy in the Year 2000

- This is a "spectacular success" scenario from the perspective of most people in the mid 1980s.
- 4 key driving forces: 1) very rapid technological progress, with information technology a leading area, 2) high consumer demand, with emphasis on products for improving personal and organizational productivity, 3) the globalization of the economy, with greatly expanded, hotly competitive, and relatively free trade forcing change faster than expected, 4) achievement-oriented values.
- High economic growth, led by the information-oriented sectors of the economy; rising affluence and consumption, rising productivity, and low unemployment. This growth was made possible by rapid technological progress, competent and effective management, consensus over goals and values, and the stimulus of global economic competition.
- Globalization of the economy: greater coordination of national economies, key role of transnational corporations, markets for U.S. companies grew rapidly, relatively free trade, developing countries used information technology to leapfrog the Industrial Revolution; many problems, growing pains, international tensions, but they did not derail the growth of the global economy, which provides rewards to everyone; Third World debt was written off gradually.

- There is an open international marketplace for information goods and services. The enormous and growing volume of trans-border data flows has overwhelmed most efforts to restrict information flow. Internationally accepted principles have been formulated in areas such as market access, equal treatment, and tariff and subsidy policy.
- Achievement values dominate: high optimism, achievement motivation, desire for material rewards, consumption-oriented leisure; some growth of expressive/societally conscious values led to better resolution of major societal problems.
- Potential problems also avoided through good management and good luck, and because key problems like energy, the environment, and Third World development were not nearly as difficult as they seemed in the 1970's and 1980's.
- Modest and generally adaptive changes occurred in organizations.
- Information technologies promoted the diffusion of many points of view and acted as a strong force for democratization and freedom, even in repressive societies elsewhere in the world.
- In many respects, this scenario is a fulfillment of the traditional American dream, aided by powerful information technologies.

Technology in the Year 2000

- Advanced information technology products are widespread in the year 2000.
- The shifting of effort from basic research into applied research sped up with global competition and led to rapid product development; the shift of many top scientists toward applied research slowed down long-range, theoretical, basic research, but this did not have obvious adverse consequences by 2000.
- The extrapolative projections of technological progress from the mid 1980's were fulfilled or exceeded in all areas: microelectronics, computing technology, software, AI, telecommunications, input and output devices, and system integration.
- Breakthroughs occurred across a wide range of key technologies such as wafer-scale integration, computer aids for software design, E-beam recording and tunable laser storage.

Applications in the Year 2000

- In the business sector there was rapid growth, penetration and substitution of new information technologies because of their capacity to enhance productivity. This allowed the information industry's sales to the business sector to grow at twice the rate of the GNP for the last fifteen years of the 20th Century. From the home, information industry revenues grew at the same rate as the GNP.

- Major applications include expert system automation of routine word processing, text management, the early phases of standardized decision-making (eg. basic qualifications in loan processing, competitor analysis, and procurement); speech recognition/speech synthesis is used for order taking, other routine customer interaction and as significant input/output devices within the office; very sophisticated simulations are commonly used for decision-making and for worker training; "AI agents" provide information searching in virtually any database world wide; hypertext stores and sorts textual information in multiple layers of meaning, noting its relationship to other stored material, the output of which is geared to the knowledge level and learning style of the person involved; hypertext benefits from the massive storage available to each office in the compact disks and related technologies stored on site, and the equally massive amounts of information stored on the network which is now far more accessible.
- Information products, particularly databases, are used very effectively by "agents", providing high quality, personally tailored clipping services. Nearly real time market research is common, benefiting from the significant percentage of business and household transactions that are conducted electronically as well as better systems for capturing the results of physical transactions. Largely electronic transactions were fostered by the utility-like nature of information and communication equipment that became common in the 1990's. "Location-independent-work" also grew, greatly enhanced by the ISDN phone system, enhanced network intelligence and the power of portable computer/communication equipment.
- Home applications spread rapidly through upscale homes; the phone system includes a very sophisticated computer system; advertiser and vendor revenues make electronic transaction systems inexpensive for the home user.
- Home applications are extensive in home management, education, entertainment, health care, personal business management, and shopping.

Public Policy Issues in the Year 2000

- Privacy was not as difficult a problem as some expected. Given the extensive information on daily life that is now captured and stored electronically, people have come to accept a higher level of potential scrutiny. Widespread use of low cost encryption technologies also eased some concerns. So the computer became part of the solution to many aspects of the privacy protection issue.
- Government plays a smaller role in the information marketplace. Competition from government is now minimal. Deregulation continued and anti-trust enforcement was relaxed. Government plays a limited, constructive role in areas such as R&D, information literacy, workforce retraining, and facilitation in standards setting.
- Heavy reliance is put on the marketplace in the area of intellectual property. Technological safeguards ease the copyright problem. There is little adjustment of the copyright law. The exclusivity of commercial

information is maintained where the information is not derived from more publicly available sources. (Expert systems made it easier for users to create their own value-added applications if they had access to the raw data.)

- The aging of the population, effective computer literacy instruction in the public schools, and expanded private sector training programs result in near-universal computer literacy in the under-50 population.

THE CREATIVE SOCIETY

Scenario Overview

The Creative Society also assumes rapid technological progress and a dynamic economy. In this scenario, however, the information revolution combines with a profound change in values: more expressive, socially concerned values lead to a recognition that the heart of the information revolution's is human creativity. Enhanced productivity is sought not only for financial success but increasingly for the personal growth and social advancement it can make possible. A strong emphasis on basic research provides breakthroughs in neural networks, parallelism, and knowledge representation. Privacy is protected diligently by the industry and by government. Government intervenes less in the information marketplace, while its policies become more coherent and far-sighted. Business applications include those in the "High Tech" future. Home information use grows even faster than in the "High Tech" scenario. Public libraries flourish as they foster new CD-ROM based pay-per-use approaches that adequately compensate authors and publishers and make massive amounts of information widely available.

Society and Economy in the Year 2000

- This is a "success" scenario that represents a different image of success.
- Definitions of success changed as values and world views changed. The time before the year 2000 saw the transformation of Western Industrial civilization into the beginnings of a new civilization. Technologies, particularly information technologies, played a critical role in this process.
- Key driving forces: 1) Very rapid technological progress, with information technology a leading area, 2) Changing values, influencing society in many ways including changing consumer demands, 3) New organizational forms, taking advantage of the potentials of information technology, 4) A dynamic economy, 5) An emerging social vision of what a better national and global society would be like.

- The overall orientation of the society is focused on learning, human development and creativity more than on material growth. Learning came to be seen as something that takes place throughout society and throughout life, not just in schools. Various institutions continued to have their functions, and seem outwardly the same. But there was a subtle change of goals and expectations. Nearly all institutions are expected to be "educational" in a broad sense, and strict, narrow economic rationality is less influential than it used to be in organizational decision making.
- Information is broadly sought, and most individuals readily convert information into knowledge.
- Expressive/societally conscious values dominate and blend with achievement values. A new kind of "rugged individualism" emerged, focused on "personal best" rather than on winning over others at all costs. More people consciously seek "true satisfaction" and personal development, not just symbols of success. There is a high allegiance to harmony with nature and an ecological ethic. Gender role changes continued for men as well as women, as women evolved toward a fully equal role in society. There is high sensitivity to global problems and the plight of those in poor developing countries. Many Americans feel a growing sense of membership in the "human family". That did not replace national loyalty but added a new level of identity.
- Worsening global problems led to a growing belief that things could not work out if they kept going the way they were. More cooperative strategies of global development emerged in many countries, optimism increased, and cooperative efforts redoubled.
- There is now a reciprocally fair international marketplace for information goods and services. It was achieved through a long, difficult process of international discussion and negotiation. The success of these negotiations depended heavily on increased sensitivity in the U.S. and other advanced Information Societies to the concerns of other nations about "Westernization," "cultural imperialism," loss of potential tax revenue, protection of jobs, etc. Compromises with the ideal of a fully open market were necessary.
- New organization forms emerged throughout society. Corporations grew, but became more networked, decentralized, somewhat more employee owned and employee managed. Decision-making and problem-solving decentralized within the federal system, and state and local governments grew rapidly in competence. The formal economy went through a process of disintermediation and the informal economy of personal exchange and do-it-yourself efforts flourished.
- Information technologies fostered citizen participation and consumer activism and stimulated the emergence of new non-geographic "communities of interest" which now influence the political process and the marketplace.
- Considerable force built behind the idea of open access to information. Public libraries flourish, taking the lead in fostering information access and developing new mechanisms for rewarding authors.

Technology in the Year 2000

- Very advanced information technologies are common. Individuals value and use information technology but judge it less for its commercial productivity (though this is still very important) and more for its contribution to individual creativity.
- A very high priority was given to basic research. Basic research breakthroughs in the understanding of neural networks, parallelism, knowledge representation, and software creation were achieved in the 1990's. Their impact on product development will continue to grow in the years after 2000.
- The extrapolative projections of technology development from the mid 1980's were fulfilled or exceeded in all areas.
- The greatest area of technological breakthrough was neural networks.
- Information technology penetrated deeply into the home market because of the growth in more fundamental types of information literacy, very rich networks via the local telephone companies, and massive storage in the house, along with vendor and advertiser revenues for the network.

Applications in the Year 2000

- In the business sector there was rapid growth, penetration and substitution of new information technologies because of their capacity to enhance productivity. Businesses increasingly operated in terms of "multiple bottom lines" that account for the company's net contribution to the environment and society. In the business sector, the information industry's revenues grew at a rate twice that of the GNP from the mid 1980's to 2000. Even in the home, information industry expenditures grew at 1.5 times the rate of the GNP.
- Major applications included expert system automation of routine word processing, text management, the early phases of standardized decision-making (e.g., basic qualifications in loan processing, competitor analysis, and procurement); speech recognition/speech synthesis used for order taking, other routine customer interaction and as significant input/output devices within the office; very sophisticated simulations, used for decision-making and for worker training; "AI agents" for preset information searching in virtually any database world wide; hypertext which stores and sorts textual information in multiple layers of meaning, noting its relationship to other stored material, the output of which is geared to the knowledge level and learning style of the person involved; hypertext benefited from the massive storage available to each office in the compact disks and related technologies stored on site, and the equally massive amounts of information stored on the network with is now far more accessible. New business information services allow companies to quantify and monitor the impacts of their actions on society and the environment. "Thinkware" which enhances creative thinking is common.

- Information products, particularly databases, are used very effectively by "agents", providing high quality, personally tailored clipping services. Nearly real time market research is common, benefiting from the significant percentage of all business and household transactions that are conducted electronically as well as better systems for capturing the results of physical transactions. Largely electronic transactions were fostered by the utility-like nature of information and communication equipment that became common in the 1990's. Valuable information products for market research are now also developed by consumer groups, evaluating products and services with great sophistication, and polling their members on their desires for new product/service development.
- Home applications grew in most homes because of "intelligence" built into home appliances; the phone system has remained very utility-like and became a very sophisticated computer system; advertiser and vendor revenues support the operation of the system. The prime reason for growth was the ongoing search for knowledge to enhance personal wisdom. A related, important factor was the opportunity for meaningful cross-cultural exchanges thanks to inexpensive video phone lines and language translation capacities.
- Home applications are extensive in home management, education, entertainment, health care, home/personal business management, and shopping. Consumer electronic bulletin boards make local and national markets much "smarter" by evaluating vendors and by exploring what new products could be developed.
- The interest in creativity and equity meant that most households and all offices have or make use of agents, hypertext and "thinkware."
- Privacy remained the top public concern related to information technology. Privacy abuse scandals by both government and some information companies put the issue high on the political agenda and new legislation was passed during the early 1990's. Policy makers strove to substantially increase privacy protection while avoiding unnecessary or unanticipated adverse impacts on business and government. Information industry companies took an active part in ensuring privacy protection by developing technical fixes for information security, adopting privacy codes, helping to develop legislation, and providing a model of exemplary behavior.
- The role of government decreased overall as government adopted a strategy of low intervention in the information marketplace combined with high coherence of government policy. Regulation and competition from government decreased. Government worked to ensure "smart markets" where consumer ratings of goods and services are easily available. Basic research funding increased.
- New approaches are taken toward proprietary rights. Copyright law was adopted to technological change and marketplace practice and ethics changed substantially. Shareware software distribution became common (pass this to your friends, if they use it, they send money to this address). Pay-per-use approaches became common to take advantage of the massive storage capacity of CD-ROM disks and their successors. The CD disk acquisition cost is now very low because most of the revenue is

generated on the pay-per-use basis, with gradations for browsing, reading the whole text, and printing out a copy. Using this approach, every local library has nearly the entire contents of the Library of Congress.

- Both the government and the private sector play a strong role in promoting information literacy. Information literacy is defined in a broad way. It includes conventional computer literacy. It also includes an emphasis on learning how to learn, thinking and problem-solving skills, and the ability to search out information effectively. At a still higher level, it includes an emphasis on developing distinctly human capacities such as intuition, creativity, imagination, self-awareness, interpersonal skills, and "wisdom".

THINGS BOG DOWN

Scenario Overview

The Things Bog Down scenario assumes slow technological progress exacerbated by AI failures in business and the military, weak consumer demand, and unresolved domestic and global problems (e.g., increased chronic unemployment, precipitous debt defaults). Even in this scenario there are still major technological advances. Privacy problems worsen. Hard times lead government agencies to raise money through information sales. Copyright enforcement becomes more difficult. Information gaps between rich and poor do not create poverty, but they amplify existing inequalities.

Society and Economy in the Year 2000

- This is a "disappointment" scenario, a slow growth future rather than a disastrous one.
- 5 key driving forces: 1) Technological change, significant but slower than hoped for, 2) Periodic severe recessions, 3) Weak consumer demand in many high-tech areas that had been expected to lead the economy, 4) A hotly competitive global economy with protectionism, trade wars and uneven development, 5) Serious global problems demanding attention and investment.
- Economic growth slowed during the 1990's; The rich became richer, the poor, poorer, and many middle class people became downwardly mobile; unemployment has been chronic and structural; political debates rage over the cause of economic problems, with different people emphasizing different factors such as slow technological progress, the impacts of manufacturing and office automation, poor economic management, deep divisions over goals and values, federal budget deficits, turbulence and protectionism in the global economy, etc.
- Globalization of the economy: periodic problems in large national economies ripple through global economy; lack of coordination of national economies persists; rise of Asia continued through the 1990's; intense competition included strategies of government subsidy and protectionism; faltering growth, large debt levels and some debt defaults in the Third World.
- Information protectionism became a major topic of international debate. Many nations put restrictions on the flow of information goods and services. National motives varied widely and included: strategies for promoting domestic industries and protecting domestic jobs, reactions against "Westernization" and "Information Imperialism," concerns over

privacy and security of data, fears of loss of potential tax revenues, fears of overdependence on foreign sources of information and information technology.

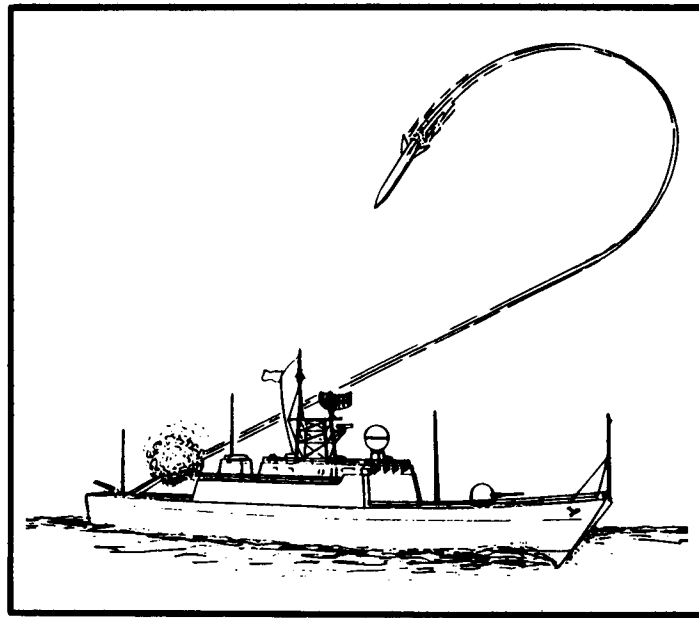
- The U.S. increasingly became a two-tier society. A shrinking force of blue-collar workers has less disposable income and purchasing power; office automation caused a shrinking of the white-collar work force while demographic developments thinned the ranks of middle management; new technology generated lower-skilled and lower-paying jobs in far greater numbers than higher-paying jobs; as information became a more critical economic resource, the growing economic inequalities became more visible.
- Achievement values still dominate and people desire material rewards. But a general sense of frustration pervades the public. Expressive/societally conscious values became more common, as did survival/control values. The sharp divisions in value orientation made public life more contentious.
- Global problems such as the arms race, regional tensions, terrorism, population growth, energy, the environment, famines, unemployment, and climate change all worsened. The problems are now being taken seriously and efforts to cope with them are substantial, though constrained by the periodic recessions. Many regret that more was not done sooner.
- Strong resistance to organizational change slowed some of the most productive and creative uses of information technology. Concern for long term welfare of workers diminished as the numbers of capable but unemployed workers grew, furthering the decline of the middle class.
- Information technologies promoted diffusion of many points of view; decision-making became both more contentious and better informed. However tolerance of divergent opinions grew little.

Technology in the Year 2000

- Information technology did progress substantially, but more slowly than many technological optimists had hoped for. Software development problems proved especially serious.
- Exaggerated expectations about AI, followed by limited progress and expensive failures, cast doubt on the AI enterprise. AI applications to battlefield management, (Figure 6-2 illustrates one problem) business decision support, education and other areas proved dangerously inadequate. They lacked crucial capabilities such as holistic pattern recognition, intuition, imagination, creativity, adaptiveness to unique and changing situations, interpersonal skills, and moral responsibility, yet were used in settings where they were treated as if they had these capabilities.
- The extrapolative projections of technological progress were fulfilled in most but not all areas.
- No significant breakthroughs occurred that went beyond the extrapolative projections.

- Foreign competition took the market share away from U.S. manufacturers in more and more areas of information technology.

Figure 6-2: AI Software Malfunction



Source: Herman O. Lubbes, presented at Computer Assurance Conference, Washington, D.C., July 7-11, 1986, cited in Ivan Patterson "This Software May be Unsafe," Science News, September 13, 1986, p. 171.

Applications in the Year 2000

- In the business sector the growth and substitution of new information technologies was slow and their overall penetration was moderate. Yet even this moderate penetration was enough to have significant negative effects on employment. This reduced consumption, further reducing demand and hurting business. Despite the potential for productivity gains, information use in business grew only as fast as the sluggish GNP. In the home the growth rate for information expenditures ran behind the GNP and a smaller percent of household budgets is now spent on information than in 1985.
- Major applications that did have moderate penetration into the business sector include expert system automation of routine word processing, text management; speech recognition/speech synthesis used for order taking, other routine customer interaction and as significant input/output device within the office; sophisticated simulations, used for decision-making and for worker training.

- Some highly advanced technologies exist but have almost no distribution outside the defense department or a few very large companies. These include hypertext which stores and sorts textual information in multiple layers of meaning, noting its relationship to other stored material, the output of which is geared to the knowledge level and learning style of the person involved.
- Information products, particularly data bases, are used only where they clearly have a favorable cost/benefit impact. This spurred the development of expert systems which can do cost/effective searching and provide inexpensive, high quality, personally tailored clipping services.
- Much business-to-business transaction is conducted electronically. The large percentage of electronic transactions among those companies which replaced their information technologies during the 1990's were fostered by the utility-like nature of information and communication equipment that became available in the 1990's.
- Market research did benefit from the shift of upscale consumers to nearly all electronic transactions.
- Home information applications grew little in most homes. Appliances purchased in the 1990's generally had some degree of "smart" embedded computing capacity, but few homes made significant investments in creating the "smart home". The expected link between information and entertainment via CDI technology did not emerge. Phone system capacity was upgraded slowly. RBOC's were closely regulated and discouraged from diversifying. Intermittent recessions and low consumer interest meant that in the year 2000 most households have little more in-home capacity via their telephone and the connecting network that they had in the late 1980's.
- Vendor and advertiser subsidies for electronic transactions are targeted to the upscale household.
- Some low-cost home applications have achieved widespread penetration, such as electronic notebook/checkbooks that give each family sophisticated capacities for money management. These penetrated the market because of their very low cost and because of their quickly demonstrable payback in terms of the household's finances. Also VCR technology is widely distributed. Broadcast television remained a major home medium because of its free reception, though quality declined as significant proportions of advertising revenues followed the upscale market into expensive pay cable and other media.

Public Policy Issues in the Year 2000

- Privacy was a major public concern related to information technology. Government passed comprehensive new privacy legislation and created a regulatory structure for private sector information practices. The concern for privacy limited free flows of information and impaired performance in some areas of business (e.g. credit bureaus). Some information industry companies were lax in implementing the safeguards on consumer confidentiality and scandals reoccur periodically.

- The role of government in the information marketplace increased. The pressure on government agency budgets leads to more competition from government as agencies try to offset costs by producing and selling enhanced information packages.
- Many gaps developed in proprietary rights protection, and they continue to grow due to rapid technological change. They are dealt with slowly by the court system on a case-by-case basis without adequate legislative guidance, and in the marketplace, largely by maintaining the exclusivity of commercial information. Copyright enforcement worsens.
- Basic information literacy improves due to private- and public-sector efforts and the aging of the population. As the U.S. tends toward a "2-tier" society, a gap widens between the "Knows" and the "Know-Nots."

Scenario Overview

1984 and Beyond is a pessimistic scenario. Economic hard times combine with an AIDS epidemic and terrorist incidents to lead the public to accept much greater discipline and surveillance. Increasing digitization of the exchanges of daily life facilitates government imposed social controls. Technological progress slows in the late 1980's but rebounds as the more disciplined economy grows through the remainder of the 1990's. Business applications of information technologies are extensive. Public indifference to many small privacy intrusions in the late 1980's and the growing terrorist threat allow surveillance on a large scale to be put in place. At that point privacy becomes a non-issue. As the government puts it, "those who do nothing wrong have nothing to hide." The government simultaneously stimulates and subtly censors the information industry. New copyright concepts give the government more control. A "freedom fighter" underground of computer hackers emerges.

Society and Economy in the Year 2000

- A "bad times" scenario where economic distress combined with many other problems led the U.S. toward a more authoritarian society.
- 3 key driving forces: 1) Inch-by-inch encroachments on privacy led people to become indifferent to them; 2) Prolonged recession/depression occurred in the U.S. as part of a larger breakdown in the global economic system; 3) A perception grew that many problems, including terrorism and AIDS, were spinning out of control; 4) The fear that chaos was likely without very firm measures reinforced the movement to greater discipline in society.
- The worst economic conditions since the Great Depression spread across the world in the late 1980's. The precipitating event was a coordinated loan default by a half-dozen heavily indebted developing countries. The deeper reasons are still much debated. Different people stress factors such as the irresponsibility of the debtor countries (including the U.S. as the largest debtor nation), the lack of caution in making the original loans in the 1970's and 1980's, the political backlash in the third world debtor countries against austerity conditions imposed on them by international lending institutions, the return of high interest rates,

the U.S. budget deficits, and trade policies that discriminated against developing countries.

- Problems on the global scale were widely perceived as being out of control: famines, anti-American riots in fast-growing Third World urban slums, deforestation and desertification, nuclear power plant accidents, and many more.
- The depression of the early 1990s reduced the global information marketplace, and "every-nation-for itself" policies have kept it stunted. Open markets and reciprocally fair trade policies became a thing of the past. Many other countries have also taken an authoritarian turn and have their own reasons for putting restrictions on transborder data flows.
- Terrorist activities within the U.S., especially the sabotage of electric transmission lines, natural gas pipelines and fiber optic "information pipelines", made people feel vulnerable. Intermittent bombings reinforced that feeling in many cities. There was much speculation about the possibility of nuclear terrorism.
- AIDS infections spread rapidly through all social groups, reaching 10 million people by 1988, 25 million by 1990, and over 100 million by 2000. Thirty percent of those infected actually got the disease. The development of a highly effective vaccine and of other immune system enhancing capacities prevented a catastrophe comparable to the Black Death in Europe in the 1300's. Nevertheless, millions of people died. The public accepted any government control measures that promised to check the spread of AIDS, including mandatory regular blood testing, open medical records, quarantines, and tattooing of all people who tested positive for the AIDS virus.
- The increasing diversity of information sources produced a fragmentation of viewpoints. Single issue groups paralyzed the political process more than ever. These conditions led to a need for "strong leadership" to pull America together.
- Survival/control values came to the fore and blended with achievement values. The strongest psychological reactions to the deteriorating situation were, first, a xenophobic, protectionist, "save ourselves" attitude, and second, a willingness to abandon many traditional freedoms for the sake of restoring order, social discipline, and security.
- Socio-economic activity is now monitored by very sophisticated systems, based largely on the electronic transactions system. The boundary between the public and private sectors was increasingly blurred. The government maintained some elements and most of the trappings of democracy. Its more draconian measures were justified as having a short-term, emergency nature. The government's "news management" efforts expanded far beyond all past efforts. The most sophisticated advertising/public relations techniques are now used to shape opinion. The news media remain privately owned, but are now increasingly docile.
- Some fear the government is drifting too far in an authoritarian direction, but this view is not popular because the government has been very successful in restoring order and economic growth. People who now

think of themselves as a "democratic resistance" include many computer hackers and others capable of disrupting information systems; this occurs with increasing frequency. An information underground formed and uses decentralized mass storage, physically delivered. Stiff sentences are given to any underground members who are caught.

- By the mid-1990's, the U.S. economy had recovered; the remainder of the 1990's were a time of healthy economic growth; much of the rest of the world did not make as successful a recovery.

Technology in the Year 2000

- Information technology did progress substantially, despite depression and turmoil, because of its productivity enhancing capacity and because the government made it a top priority.
- The direction of technological development was highly influenced by government policy.
- The extrapolative projections of technological progress developed in the mid-1980s were generally fulfilled.
- No fundamental breakthroughs occurred beyond the extrapolative projections, but highly advanced applications were developed for surveillance, information gathering, and social control.
- Government got access to all commercial transaction data bases, (including expenditures, travel, magazine subscriptions, data base or other electronic information retrieval; medical and employee files). The government also takes advantage of the databases, originally started in the 1980's by right wing groups, which identify potential radicals, Soviet sympathizers, and others thought to be a potential threat to U.S. stability. The government accesses this information without consumers' knowledge or consent, but with the assent of the information companies (paying a fee for accessing the information). The government systems link this information to IRS data and welfare agency data to catch tax and welfare fraud but also to monitor potential subversives.
- Police departments have equipment capable of monitoring large volumes of local telephone traffic and searching for key words which, if spoken, activate recording and call tracing.
- Telephone and CATV systems were "tampered with" for surveillance. Many new high-tech surveillance tools were available. The fight against domestic terrorism was used to justify initial widespread use, much of which has persisted.
- Electronic files are easily altered or corrupted by the government, business and organized crime without any trace of the modification.

Applications in the Year 2000

- After the Depression, there was rapid growth, penetration and substitution of new information technologies in the business sector because of their capacity to enhance productivity.

- Computer matching and profiling, electronic surveillance technologies, and other advanced applications give government a greatly enhanced ability to monitor work, communication and other daily activities.
- Major business applications include expert system automation of routine word processing, text management, the early phases of standardized decision-making (e.g., basic qualifications in loan processing, competitor analysis, and procurement); speech recognition/speech synthesis used for order taking, other routine customer interaction.
- Agents and hypertext devices are generally unavailable outside government and approved companies.
- Home applications grew modestly. The phone system remained very utility-like and by the year 2000 became a sophisticated computer system. In the tradeoff between network vs. onsite computing power and storage, the government encouraged network development, and discouraged on-site capability. This allowed monitoring of most information access.
- Database access was allowed for the appropriate databases. Where the information is sensitive, or threatening to domestic tranquillity, access to databases was restricted. This discouraged information vending companies from creating or maintaining databases determined by the government to be sensitive.
- A large underground of information is passed on CD and VCR formats.

Public Policy Issues in the Year 2000

- Privacy became a non-issue. There is no privacy necessary for honest citizens who pay their taxes and don't engage in unlawful or immoral behavior. Privacy legislation of the 1970's and 1980's was deliberately violated or set aside. Citizen access to many databases was blocked for reasons of national security. But corporate or government access to all databases, including those on transactions and personally sensitive information such as medical conditions (including genetic predispositions), school and employee records, and financial transactions was an ongoing reality, wherever there is probable cause for suspecting an individual of a commercial, civil or political crime. Expert systems periodically match databases and monitor telephone/network traffic to do random checks to see if there may be probable cause.
- Government assumed a dominant role in the information marketplace. Government policies drove the development of information technology. The complex new alliance of government and big business increasingly controlled access to information. Tax credits were used to encourage the creation of certain kinds of information. Government also coordinated U.S. competition in the international marketplace, setting priorities for technology development, coordinating private sector efforts, providing subsidies, providing tariff protection for domestic industries, etc. The "Baby Bells" have been merged back into a single system.

- The protection of proprietary rights was used as a rationale for revising the copyright statutes. This made it easier for the government to block "sensitive" copyrights and patents, putting a cover over them for reasons of national security. New laws of "information eminent domain" allow the government to take private information for public use.
- Basic office-level computer skills are widespread, but more advanced forms of information literacy are rare. There is a sharp division between the information "Knows" and "Know-Nots."
- Domestic data access controls were initiated to prohibit access to sensitive data, often related to national security, and to allow prosecution of those caught with it in their machines. In addition to the specific controls, the fact that virtually all transactions and electronic information seeking is monitored lowers people's interest in accessing information that might make them subject to greater scrutiny.

Table 6-1: The Information Millenium: Alternative Futures In The Year 2000

SOCIETY AND THE ECONOMY Overall Character	THE HIGH-TECH INFORMATION SOCIETY		THE CREATIVE SOCIETY		1984 AND BEYOND	
	THE HIGH-TECH INFORMATION SOCIETY		THE CREATIVE SOCIETY		THINGS BOG DOWN	
	An "unqualified success" future. A "Herman Kahn" future.	A "different kind of success" future based on creativity, learning and human development. A "Third Wave" future.	A "disappointment" future but not a disastrous one.	An authoritarian future that occurs as a reaction to hard times. A "1984" or "Brave New World" future.		
Key Driving Forces	Very rapid technological progress. High consumer demand, emphasis on improving productivity. Greatly expanded, competitive, relatively free global trade. Mood of confidence, optimism.	Very rapid technological progress. Changing values. New organizational forms. Dynamic global economy. Emerging vision of a better society focused on creativity and "the human resource".	Slower than hoped for technological progress. Weak consumer demand for many information goods and services. Hotly competitive global economy with protectionism, trade wars. Serious global problems.	Hard times in global economic system. Global problems worsen. The growing diversity of information sources produces a fragmentation of viewpoints, contributing to a chaotic political system. Terrorism, AIDS crises.		
Economic Conditions	Booming economy. Rising consumption and productivity. Low unemployment.	Dynamic economy. Disintermediation in formal economy. Informal economy flourishes.	Slow growth in 1990's. U.S. increasingly a two-tier society. Chronic structural unemployment. Weak consumer demand. Weak savings and investment.	Depression at start of 1990's. Economy recovering by 2000 due to strong government action.		
Values	Achievement Values dominate: optimism, achievement motivation, desire for material rewards.	Expressive/Societally Conscious Values dominate and blend with Achievement Values. Desire for "true satisfaction," not just symbols of success. Harmony with nature, equalizing role changes for women and men, sense of membership in a single "human family" and responsibility for its welfare.	Achievement Values dominate, but people are frustrated. Value divisions make public life more contentious.	Survival/Control Values grow. A xenophobic "save ourselves" attitude. Willingness to sacrifice freedoms for the sake of order and security.		
Globalization of The Economy	Greater coordination of national economies. Key role of multinational corporations. Growing, relatively free trade.	Greater coordination of national economies. Shift emphasis toward human resources development.	Problems of large national economies ripple through global economy. Rise of Asia. Intense competition with protectionism, trade wars. Faltering growth and high debt in developing countries, with some defaults on loans.	Near collapse of international monetary system at start of 1990's. Continued but hampered international trade.		

Table 6-1: The Information Millennium: Alternative Futures In The Year 2000, Page 2

THE HIGH-TECH INFORMATION SOCIETY		THE CREATIVE SOCIETY	THINGS BOG DOWN	1984 AND BEYOND
SOCIETY AND THE ECONOMY CONT. Global Problems Political Economy - Characteristic Impact of Information Technology Organization Change	Key problems not as difficult as they seemed in the 1970's and early 1980's. Technological progress and good management keep problems under control.	Global problems and value shifts lead to more cooperative strategies of global development.	Key problems have all worsened. Efforts to cope with them are now substantial, but constrained by periodic recessions.	Key problems seem "out of control." Terrorist activities common, including sabotage of key communications "pipelines."
	Information technology spurs economic growth, increases citizen access to information and promotes the diffusion of many points of view.	Information technology contributes to a profound "change of civilization." It fosters citizen participation, consumer activism and the emergence of non-geographic communities of interest. It is a strong force for democratization and freedom, even in repressive societies. A focus on information becomes a focus on "the human resource."	Information technology accelerates shrinking of the mid-level white and blue collar work force. Creates more lower paying than well paying jobs. Enlarges already existing inequalities.	Increasing diversity of information sources leads to fragmentation of viewpoints and chaotic political process. Later, advanced applications of information technology used for surveillance, social control, restraining chaos. Boundary between public/private sectors blurs.
	Modest change, generally adaptive.	Considerable change, and awareness of it. Networked corporations. Decentralization in federal system. Disintermediation in formal economy. Overall shift from hierarchy toward "heterarchy."	Strong resistance to change slows potential uses of information technology	Rapid change with information technology used to reinforce authoritarian control.
INFORMATION TECHNOLOGY				
Microelectronics	Breakthroughs in reducing line widths, wafer-scale integration, compound materials. 100 million transistors on a chip.	100 million transistor chips. Breakthroughs in reducing line widths, neural networks, other areas.	10 million transistors on a chip.	10 million transistors on a chip.
Computing Technology	10 to 40 MIPS single processor computers. Progress in parallel architecture computers.	10 to 40 MIPS single processor computers. Breakthroughs in understanding of parallelism. Dramatic progress in neural networks and massively parallel architectures.	10 MIPS or less single processor computers. Limited progress in multiple processor, parallel architecture computers.	10 to 40 MIPS single processor computers. Limited progress in multiple processor, parallel architecture computers.

Table 6-1: The Information Millennium: Alternative Futures In The Year 2000, Page 3

INFORMATION TECHNOLOGY CONTINUED	THE HIGH-TECH INFORMATION SOCIETY	THE CREATIVE SOCIETY	THINGS BOG DOWN	1984 AND BEYOND
INFORMATION TECHNOLOGY CONTINUED				
Software	Improvements in computer aids for software design accelerate software productivity.	Improvements in software productivity. Breakthroughs in knowledge representation and development of a strong scientific basis for software creation.	Software remains bottleneck.	Software development standardized.
Storage	Breakthroughs in RAM chips; full read-write-erase capability CD. Breakthrough to tunable lasers or E-Beam recording with 50 gigabytes on a CD.	Breakthroughs in RAM chips; full read-write-erase CD. Breakthrough to tunable lasers on E-beam recording with 50 gigabytes on a CD or equivalent.	Improved RAM chips; CD-WORM displaces much magnetic storage. 3 gigabyte CDs or equivalent.	Improved RAM chips; CD-WORM available but discouraged because of subversive possibilities. 5 gigabyte CD's or equivalent.
Artificial Intelligence (AI)	Progress due to supportive breakthroughs in chips, software, storage, etc. Knowledge representation is still a bottleneck.	Rapid progress. Breakthroughs in neural networks, knowledge representation, parallel architectures.	Exaggerated expectations followed by modest progress and expensive failures. Though expert systems widely used in marketing and commercial aspects.	Modest progress in expert systems, sensory systems, natural language processing and speech recognition, database searching.
Telecommunications	Extensive use of light wave systems. Rapid progress in optical fibers, lasers, signal detection, wavelength multiplexing. Switched telephone network end-to-end digital and standardized.	Extensive use of light wave systems and rapid technical progress. Switched telephone network end-to-end digital and standardized. Breakthroughs in optical switching and cost of cellular phones.	Light wave systems for much long distance telecommunication. Switched telephone end-to-end digital and standardized.	Light wave systems for much long distance telecommunication. Switched telephone end-to-end digital and standardized.
Input and Output Devices OCR=Optical Character Reader SR=Speech Recognition	OCR's read all standard fonts and hand-print. 10 - 15,000 word vocabulary, speaker-independent SR. High resolution, flat screen displays common. Non-impact printing dominates.	OCR's read all standard fonts and hand print. SR of well over 15,000 words of continuous speech. High resolution, flat screen displays common. Non-impact printing dominates.	OCR's read most standard fonts. Task-oriented SR systems with a few thousand words of continuous speech. Medium resolution, flat screen displays. Non-impact printing dominates.	OCR's read most standard fonts Task-oriented SR systems with a few thousand words of continuous speech. Medium resolution, flat screen displays. Non-impact printing dominates.

Table 6-1: The Information Millennium: Alternative Futures In The Year 2000, Page 4

THE HIGH-TECH INFORMATION SOCIETY		THE CREATIVE SOCIETY		THINGS BOG DOWN		1984 AND BEYOND
INFORMATION APPLICATIONS						
Electronic Information		Massive on-site storage and powerful networks mean rough balance in info location		Strength and low cost of public and private networks favor on-line access.		Some local mass-storage; networks and on-line favored.
Online vs. Physical Delivery						
Overall Information Market Growth						Government, to facilitate surveillance guides development to favor online access.
Business/Producer Sector Growth Rate 1985-2000		Twice rate of GNP		Twice rate of GNP		Twice rate of GNP after recovery
Technology/service Growth Penetration Substitution		Rapid Rapid, extensive Rapid		Rapid Rapid, extensive Rapid		Rapid after early '90s Extensive after early '90s Strong after early '90s
Household/Consumer Sector Growth Rate 1985-2000		Same as GNP		1.5 times rate of GNP		Same rate as GNP
Technology/service Growth Penetration Substitution		Slow but steady Steady and extensive Slow but persistent		Slow but steady Steady and extensive Slow but persistent		Slow but steady Most homes Slow (Info. tech. that enhances govt. monitoring, control spreads most pervasively.)
Expert Systems Domains of Application		Extensive applications. All areas and levels of business & professional work.		Extensive, effective applications. All areas and levels of business & professional work. Incorporate societal impacts into decision algorithms.		Extensive, applications Provide enhanced capacity for government monitoring of work, communication, daily activity.
Information Seeking Agents		Widely available, effective agents access relevant information automatically.		Widely available, effective agents access relevant information automatically.		Widely available but their use monitored and some information off limits.
Hypertext		Multi-media hypertexts that adapt content to the knowledge level, learning style, and interests of individual decision-makers, have limited availability.		Multi-media hypertexts that adapt content to the knowledge level, learning style, and interests of individual decision-makers, widely available.		Hypertext devices generally unavailable outside government and approved companies.
Speech Recognition Applications		Speech input, order-taking; other routine customer interaction.		Extensive speech input, order-taking; other routine customer interaction.		Speech input, order-taking.

Table 6-1: The Information Millennium: Alternative Futures In The Year 2000, Page 5

THE HIGH-TECH INFORMATION SOCIETY THE CREATIVE SOCIETY THINGS BOG DOWN 1984 AND BEYOND

INFORMATION APPLICATIONS CONTINUED

Language Translation	Extensive international use of domain specific translation devices.	Extensive international use of generalized translation. "Global village flourishes."	Limited availability of domain specific translation.	International use where government permits.
Other key business applications	Near real time market research. Single stop data base use for all info.	"Thinkware" extensively developed to aid holistic thinking, creativity. Near real time market research. Single stop data base use for all information.	Advances in market research data.	Advances in personal monitoring technologies, market research.
Interoperability	Virtually all machines can talk with all others.	Virtually all machines can talk with all others.	Most but not all machines can talk with each other.	Most machines can communicate but government prevents full compatibility of many machines.
Health Monitoring/Treatment	Common and very sophisticated.	Very common and very sophisticated.	Common, moderately sophisticated.	Common and very sophisticated.
Home security	Many homes.	Many homes.	Some homes.	Many homes.
Money management/EFT	Common.	Common.	Common.	Common.
Equipment diagnosis/repair	Very common.	Very common.	Upscale homes.	Common.
Comparative shopping/buying	Common.	Very common, and sophisticated consumer ratings.	Upscale homes.	Common.
Community networks/bulletins	Very common, extensive uses.	Very common and a major source of learning.	Upscale homes.	Common.

Table 6-1: The Information Millennium: Alternative Futures In The Year 2000, Page 6

	THE HIGH-TECH INFORMATION SOCIETY	THE CREATIVE SOCIETY	THINGS BOG DOWN	1984 AND BEYOND
PUBLIC POLICY				
Privacy	Technological solutions aid greatly. Not considered a major issue.	Policy makers and businesses strive to substantially enhance privacy protection while while not impairing efficiency.	A new regulatory structure for private sector information practices impairs performance in some areas of business.	Government defines "appropriate" privacy rights that allow government invasiveness.
Role of Government in Information Marketplace	Declines substantially. Minimal competition from government. Deregulation	Government works to ensure "smart" and "fair" markets; lessens regulation. Public	Increases in some areas, especially competition from government.	Government increasingly controls development of information technology
Government as Competitor	Decrease	Decrease	Increase	Slight Increase
Proprietary Rights	Little need to adjust public/author bargain. Heavy reliance on the marketplace, technological safeguards, exclusivity of commercial information protected through distribution channels and technology.	Public/author bargain revised to encourage greater access in light of evolving technologies. Copyright laws adjusted, marketplace practiced/ethics altered. Shareware and pay-per-use become common. Improved international copyright situation with global cooperation.	Public/author bargain not reexamined. Copyright enforcement worsens, marketplace reliance little help. Foreign piracy increased.	Public/author bargain revised to give government more control/censorship capacity. Copyright revised to recognize works of art, fact, function. System operation enhances government censorship/control.
Information Literacy	Universal basic information/computer literacy in the under-50 population, in over-50 population smart machines give easy access.	Creative information literacy defined broadly to include skills in searching information, creative problem solving, learning how to learn. Focus on distinctive human capacities of holistic thinking, creativity, intuition, imagination, etc.	High computer literacy, but growing gap between information "knows" and "know-nots." Unrealistic expectations for expert systems hinder information literacy advance.	Sharp division between information "knows" and "know-nots." Constant monitoring of information access. Very literate information "freedom fighters."

Alternative Futures and Strategic Vision

There are both optimistic and pessimistic possibilities for the Information Millennium. Those of us in the information industry, the key industry of the coming millennium, have a special responsibility to help our society steer away from the dangers and move in promising directions.

Figure 6-3: Alternative Futures and Strategic Vision

	High-Tech Information Society	The Creative Society	Things Bog Down	1984 and Beyond
Technological Capabilities				
The Industry and Applications				
Societal Implications				
Policy Issues				

Source: Institute for Alternative Futures

The scenarios in this report suggest threats and opportunities and critical success factors that need to be considered by businesses in the information industry. As Figure 6-3 indicates, an understanding of these factors is essential for creating a corporate strategic vision. Appendix 1 deals further with the process of creating a strategic vision.

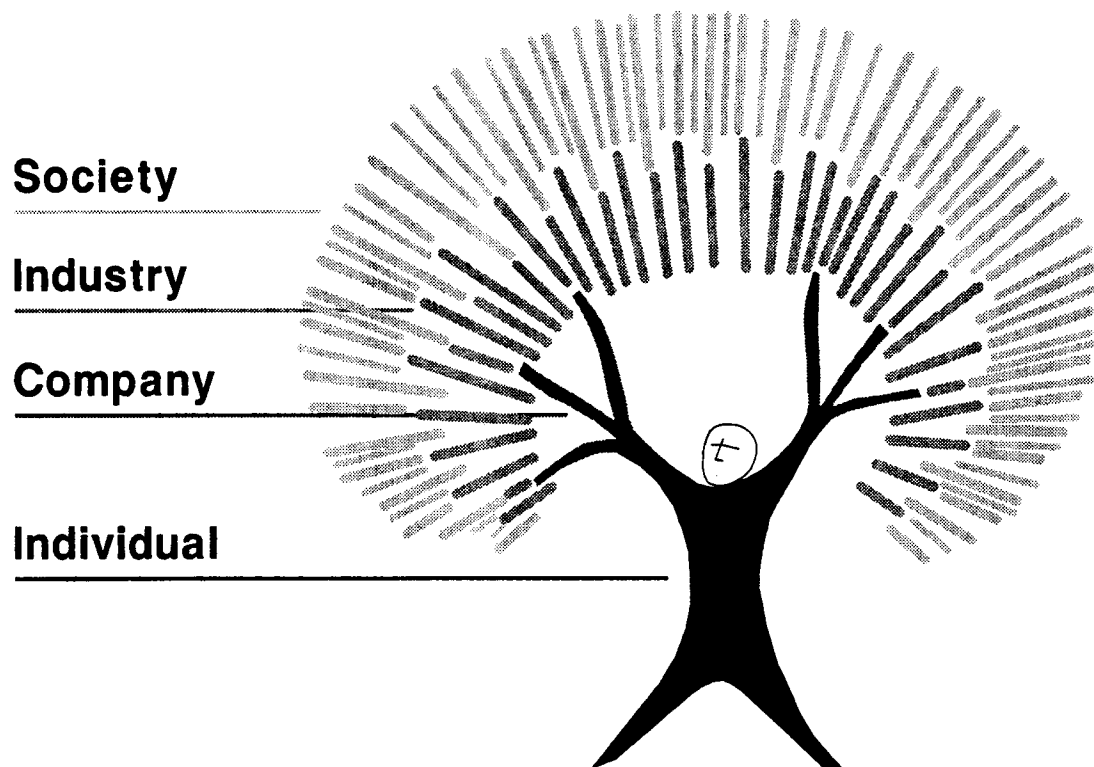
Notes

1. IAF uses forty reference scenarios on the future of the U.S. The four scenarios developed for this report were elaborations and modifications of four of IAF's reference scenarios, chosen in consultation with IIA and other information industry experts. A similar set of scenarios (without the authoritarian scenario) developed for the State of Florida can be seen in Clement Bezold and Robert Olson, "Future of Florida", The Futurist, October, 1983, pp. 12-19. For those interested in other literature on alternative societal futures we recommend Peter Schwartz, Paul Hawken and James Ogilvy, Seven Tomorrows, (New York: Bantam); and James Robertson, The Sane Society, (St. Paul: River Basin Publishers, 1979).
2. Herman Kahn, The Coming Boom, (New York: Simon and Schuster, 1982); and Julian Simon, The Ultimate Resource, (Princeton: Princeton University Press, 1981); Daniel Bell, The Coming of Post-Industrial Society, (New York: Basic Books, 1973).
3. Alvin Toffler, The Third Wave (New York: William Morrow, 1980); Willis Harman, An Incomplete Guide to the Future (New York: W. W. Norton, 1979); John Naisbitt, Megatrends (New York: Warner Books, 1983); and Yoneji Masuda, The Information Society (Tokyo, Japan: Institute for the Information Society, 1980).
4. For the "Things Bog Down" scenario see Marie Spengler and Peter Teige, Hard Times (Menlo Park, CA: Values and Lifestyles Program, SRI International, 1981).
5. For images similar to the "1984 and Beyond" scenario see Bertram Gross, Friendly Fascism (New York: M. Evans and Co., 1980); George Sanders, The Tomorrow File (New York: Berkeley Medallion Books 1976); David Burnham, The Rise of the Computer State (New York: Random House, 1983); and Robert Heilbroner, An Inquiry Into the Human Prospect (New York: W.W. Norton, 1974).

APPENDIX 1: THE ME TREE: USING THE INFORMATION REVOLUTION TO ACHIEVE A SOCIAL VISION

The Me Tree, depicted in Figure A-1, is a way of exploring the interconnections between ourselves, our jobs, our industry and our society. At each level there are choices we can make and things we can do. The Me Tree is a simple idea that can lead you into profound thinking. It can help you formulate or sharpen the strategic vision for your own company.

Figure A-1: The Me Tree



Source: Institute for Alternative Futures, based on concept of Charles Tower, The Dun & Bradstreet Corporation.

The following questions will allow you to use the Me Tree concept to clarify your preferred future and potential next steps.

Society

1. What are your estimates of the probability of each of the four scenarios in this report occurring by the year 2000? (Take 100 percent and distribute it among the four scenarios and one or two others you think as likely or more likely than these.)

2. What percentages did you give to the "Things Bog Down" and "1984 and Beyond" scenarios? Do you operate in your business life as if these futures were that likely?
3. What do you want the information society to become? What is your vision for the information millennium? How does your vision compare to the "High Tech Information Society" and the "Creative Society"? What possibilities in the scenarios are most appealing to you?

The Information Industry

1. What actions should the IIA and the information industry as a whole take to respond to threats and dangers suggested in the scenarios?
2. What actions should the IIA and the information industry as a whole take to make real some of the most appealing possibilities in the scenarios?

My Company

1. To what extent is your company playing a conscious role in helping to fulfill the promise of the information revolution? What role(s) is your company best equipped to play?
2. Is the company contributing in any way, however inadvertently, to problems and dangers identified in the scenarios?
3. What new products or services might your company develop that could enhance the creativity and social problem solving capabilities of your customers?

Me

1. What do you want your life to be like in the year 2000? (Think broadly here. Things to consider include health; standard of living; harmonious living with other "me's"; breadth of talent, skills and interests; most meaningful career accomplishments; capacity to lead a fulfilling life of your own choosing; performing actions important for the good of many people beyond yourself.)
2. Assume that what you do could "make a difference," however modest, for the future of the information society. What should you do?

Next Steps

Creating the future begins with individual steps. What one or two steps do you want to take first? What things do you want to take away from this exercise to work on?

APPENDIX 2: THE EVOLVING NATURE OF THE INFORMATION INDUSTRY

This Appendix reviews the evolving nature of the information industry. First, the role of information in the economy is considered, then varying definitions of the industry and forecasts for its growth are reviewed.

RECENT GROWTH OF THE INFORMATION COMPONENTS OF THE ECONOMY

The information components of the economy have grown dramatically in recent years, in large part because they substituted for other factors of production. From 1947 to 1972, information inputs grew from 26 percent to 34 percent of all inputs (other than direct payments to labor) purchased by the productive sector (other than household and government consumers). In real terms, this was a rise from \$132 billion in 1947 to \$506 billion in 1972, in constant 1972 dollars, according to Charles Jonscher of MIT. This growth was less than it might otherwise have been. The cost-effectiveness of information inputs began to increase dramatically after about 1975 (see below). Jonscher argues that the information component in the business/productive sector is likely to grow about twice as fast as the economy as a whole, because of continuing information sector productivity growth. This continuing growth is based on some of the factors addressed in Section 2 and the information industry megatrends in Section 3, in particular:

- 1) improving price/performance ratios of information components and devices,
- 2) similar price/performance improvements at the system or application level,
- 3) development of the telecommunications infrastructure, and
- 4) gradual reduction of institutional and social barriers to the introduction of information technology (1).

This increase in the information component of the economy is paralleled by the rise of information workers as a percent of the total workforce. In his classic study, Marc Porat argued that the information sector of the labor force has grown from less than 10 percent in 1880 to over 40 percent in 1970 and would grow beyond 50 percent in the 1980's (2).

THE EVOLVING DEFINITION OF THE INFORMATION INDUSTRY

There is a healthy lack of agreement on what the "information industry" is, how it is evolving, and how it relates to the broader "components of information" in the economy as presented by Jonscher and others. There is no "right" definition of the information industry, only different definitions useful for different purposes. For some, the information industry includes those providers of data bases and other information using on-line services; for others, it includes such information providers as consultants and seminar companies that do not use electronic means for dissemination. Some accept the broader notion that all those companies involved in the generation, packaging and/or distribution of information belong to the industry.

The Information Vending Industry: Enhanced Productivity Since 1975

In Table A-1 Joseph E. Laird of Hambrecht and Quist identifies the "information vending industry" and its sales in 1985. Using Laird's approach, the industry can be thought of as eight major products sold in eight major markets (not including households). The products are: marketing information services; economic and financial data; credit information; payroll plan services; product/price information; legal, regulatory, scientific, technical, and general business industry news. The largest of these eight products is marketing information services with about \$5 billion in annual revenues. This is also likely to continue to be the fastest growing product. The principal markets are shown on the left hand column of Table A-1.

Laird uses Figure A-2 to show the dramatic take-off in the price/performance ratio of key information technologies (computing power, storage and communications capability) that occurred around 1975. It also shows the favorable relationship of this take-off to the profitability of Dun & Bradstreet, the largest of the companies in what is conventionally thought of as the "information industry".

Laird argues that whereas the \$15 billion the "information vending industry" received in 1985 represents only about .4 percent of all industry sales, it will rise over the next 25 or so years to about 2 percent of all sales because of its growing productivity (3).

Table A-1: Horizontal Product/Vertical Market Map of the Information Vending Industry in 1985 (in millions of dollars)

H & Q	Marketing Information Services	Economic and Financial Data	Credit Information	Payroll Plan Services	Product/Price Information	Legal and Regulatory	Scientific and Technical	General Business Industry News	Total Information Sales	Industry Sales	% of Sales Spent on Information
CONSUMER GOODS											
Food/Beverage	1,050	150	25	75	25	25	25	25	1,400	163,652	.9
Health & Beauty Aids	300	50	10	25	0	0	0	10	395	29,654	1.3
Drugs/Medical Supplies	350	50	25	25	25	30	100	25	630	50,942	1.2
Autos	200	200	200	150	50	40	25	50	915	215,391	.4
General Merchandise	100	25	50	75	10	10	0	25	295	24,490	1.2
Total	2,000	475	310	350	110	105	150	135	3,635	484,129	.8
CONSUMER SERVICES											
Health Care	75	25	50	150	25	20	50	40	435	250,140	.2
Media	350	25	25	25	10	0	0	30	465	33,889	1.4
Leisure/Restaurants	90	25	25	250	10	0	0	10	410	49,811	.8
Total	515	75	100	425	45	20	50	80	1,310	333,840	.4
CONSTRUCTION	25	50	75	75	125	10	10	50	420	212,002	.2
INDUSTRIAL GOODS											
Energy	100	200	100	75	100	25	50	50	700	477,163	.1
Process Goods	50	50	50	25	50	15	15	15	270	161,225	.2
Manufacturing	100	50	50	25	25	30	20	25	325	178,283	.2
Technology	225	100	50	50	150	15	100	100	790	233,539	.3
Total	475	400	250	175	325	85	185	190	2,085	1,050,210	.2
AGRICULTURE	25	25	25	15	50	15	25	50	230	52,329	.4

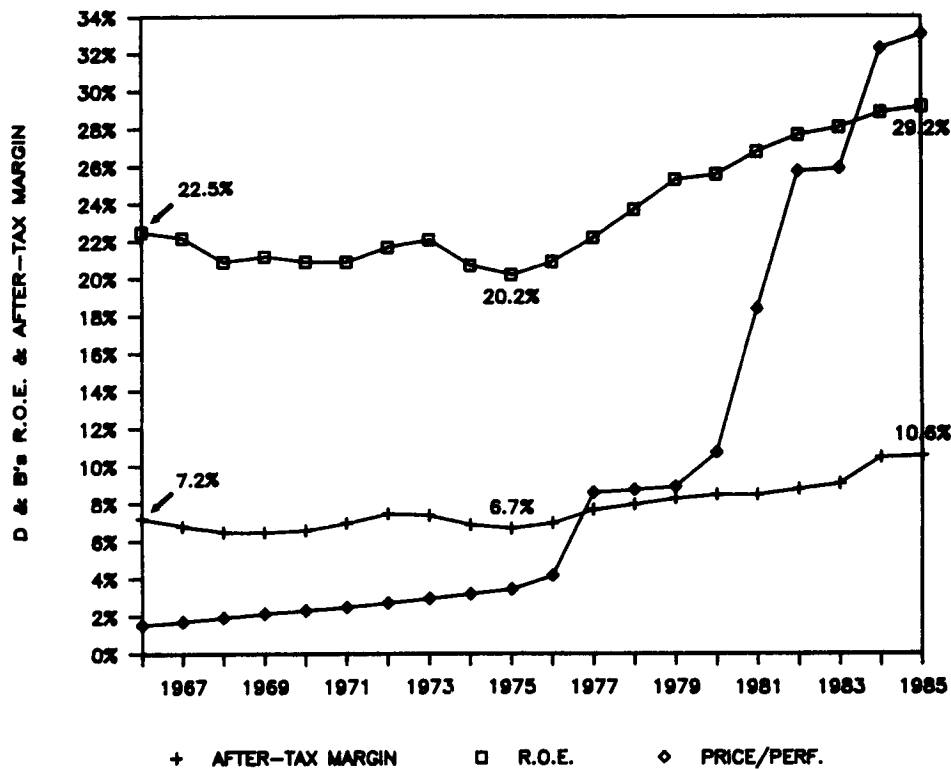
Table A-1: Horizontal Product/Vertical Market Map of the Information Vending Industry in 1985, (in millions of dollars) continued.

H & Q	Marketing Information Services	Economic and Financial Data	Credit Information	Payroll Plan Services	Product/Price Information	Legal and Regulatory	Scientific and Technical	General Business	Industry News	Total Information	Industry Sales	% of Sales Spent on Information
DISTRIBUTION SERVICES												
Retail	10	5	10	50	5	0	0	10	90	106,163	106,163	.1
Supermarkets	225	10	10	50	50	10	0	20	375	118,000	118,000	.3
Department Stores	10	5	10	25	0	0	0	10	60	20,000	20,000	.3
Drug Stores	400	10	35	150	10	0	0	25	630	54,000	54,000	1.2
Specialty Stores	15	20	75	50	25	0	0	25	210	N/M	N/M	N/M
Wholesalers	25	50	50	25	15	25	10	40	240	208,000	208,000	.1
Utilities	125	150	100	25	25	50	50	70	595	145,000	145,000	.4
Communications	25	100	100	50	125	25	10	50	485	85,710	85,710	.6
Transportation												
Total	835	350	390	425	255	110	70	250	2,685	736,676	736,676	.4
INTERMEDIATE/PROFESSIONAL SERVICES												
Legal	10	10	30	50	0	350	0	10	460	54,655	54,655	.8
Financial	125	875	25	25	20	25	0	50	1,145	25,986	25,986	4.4
Wall Street	300	150	325	50	20	25	0	50	920	196,524	196,524	.5
Banks	350	100	250	50	30	25	0	50	855	195,270	195,270	.4
Insurance	275	100	50	100	25	100	0	25	675	118,125	118,125	.7
Business/Data Services												
Total	1,060	1,235	680	275	95	525	0	185	4,055	590,560	590,560	.6
GOVERNMENT/NONPROFIT	250	50	25	25	25	50	50	50	525	N/M	N/M	N/M
TOTAL	5,185	2,660	1,855	1,765	1,030	920	540	990	14,945	3,459,948	3,459,948	.4

* All dollar amounts in millions. Industry Sales estimates are from Business Week 1000 except Agriculture and Business/Data Services figures. All other figures are Hambrecht & Quist estimates.

Source: Joseph E. Laird, Jr., Innovation in Information, Hambrecht & Quist, 1986, p. 12 - 13

Figure A-2: Technological Progress and Its Impact
on Dun & Bradstreet's Profitability



Source: Joseph E. Laird, Jr., Innovation in Information, Hambrecht & Quist, 1986, p. 3. Copyright (c) Hambrecht & Quist, used with permission.

The Information Industry in Relation to Media Industries

Laird's map of the industry focuses primarily on the content nature of the product and the market sectors in which that content is used. An alternative approach is to consider the media through which the information flows. Using this approach, Table A-2 identifies the growth since 1970 of newspaper publishing, television broadcasting, radio broadcasting, periodical publishing, book publishing, cable TV, and the information industry. In 1984, Paine Webber developed forecasts for the information industry that led them to argue that it "seems destined to become a whole new group of media industries, which at least collectively, will be the largest in the U.S. by 1990. The

Paine Webber forecast had the information industry growing from its size of \$11 Billion in 1982 to \$36 Billion in 1990 (4).

The definition of the information industry relied on by Paine Webber was one used by the A.C. Nielsen Company for its work on the Information Industry Association's study, The Business of Information 1983. According to this definition, the industry includes those companies which: 1), recognize their basic product(s)/services to be information, and 2), which have adopted a media-independent or multi-media strategy for delivering information to customers or end-users (5). Table A-2 uses this definition in its figures for the information industry (the column on the far right).

A deeper look at the media-based industries and the relative shares of their expenses and revenues is given in Table A-3, developed by information industry expert Christopher Burns. Table A-3 shows that online information services are not supported by advertising revenues, and their profitability is less than television and newspapers; it is higher than cable, radio, books, and magazines.

Table A-2: Information Industries 1970-1982 (Dollars in millions)

YEAR	Newspaper Publishing	Television Broadcasting	Radio Broadcasting	Periodical Publishing	Book Publishing	Cable Television Subscriptions	Information Industry
1970	\$6,636	\$2,808	\$1,137	\$2,708E	\$2,677	\$328E	\$771E
1971	7,037	2,750	1,258	2,922	2,814	385E	868E
1972	7,908	3,179	1,407	3,198	2,915	490	1,009E
1973	8,496	3,465	1,502	3,412	3,160	535	1,203E
1974	9,187	3,776	1,603	3,574	3,408	730	1,634E
1975	10,023	4,094	1,725	3,774	3,789	770	2,260E
1976	11,242	5,199	2,019	4,456	4,180	900	3,132E
1977	12,468	5,889	2,275	5,529	5,008	1,040	4,318E
1978	13,800	6,950	2,635	6,519	5,641	1,270	5,671E
1979	15,531	7,875	2,874	7,434	5,820	1,480	6,892E
1980	17,158	8,808	3,265	8,419	6,411	1,721	8,364E
1981	18,920P	9,815	3,650	9,027P	6,990P	2,073	9,759
1982	20,720P	10,960P	4,010P	10,154P	7,585P	2,420P	11,004

Sources: Paine Webber Mitchell Hutchins, Inc., The Information Industry: Basic Analysis, March 12, 1984. based on 1983 U.S. Industrial Outlook (and prior editions); The Business of Information 1983; Paine Webber Mitchell Hutchins estimates. "E" signifies an estimate of historic size; "P" signifies that the number was a preliminary figure at the time it was published.

Table A-3: Distribution of Revenue and Expenses of Information Sectors: 1984

	DOCUMENT RETRIEVAL	ONLINE	CABLE	RADIO	PRINT	BOOKS	MAGAZINES	TELE- VISION	NEWS PAPERS
REVENUE									
Total (In Billions)	.66	3.65	5.95	7.01	10.98	12.01	13.05	22.17	29.35
REVENUE									
Equipment	0%	15%	0%	28%	0%	0%	0%	38%	0%
Service	100%	77%	91%	0%	100%	36%	30%	0%	27%
Advertising	0%	0%	9%	72%	0%	0%	55%	62%	73%
Industry	0%	9%	0%	0%	0%	64%	15%	0%	0%
EXPENSES									
(% Distribution)									
Creation	12%	17%	14%	24%	30%	15%	17%	17%	16%
Conversion	15%	33%	15%	26%	10%	11%	12%	24%	16%
Distribution	70%	39%	67%	45%	46%	69%	62%	23%	52%
Profit	4%	11%	4%	6%	15%	5%	9%	35%	16%

Note: **Creation:** Percentage of revenues that goes to the initial production of a work, including royalties, artwork, and editing. **Conversion:** Percentage of revenues that goes to embodying work in reproducible form, i.e., typesetting, entering data into a computer, film negative cost, master recording cost, etc. **Revenue:** Estimated 1984 industry revenue.

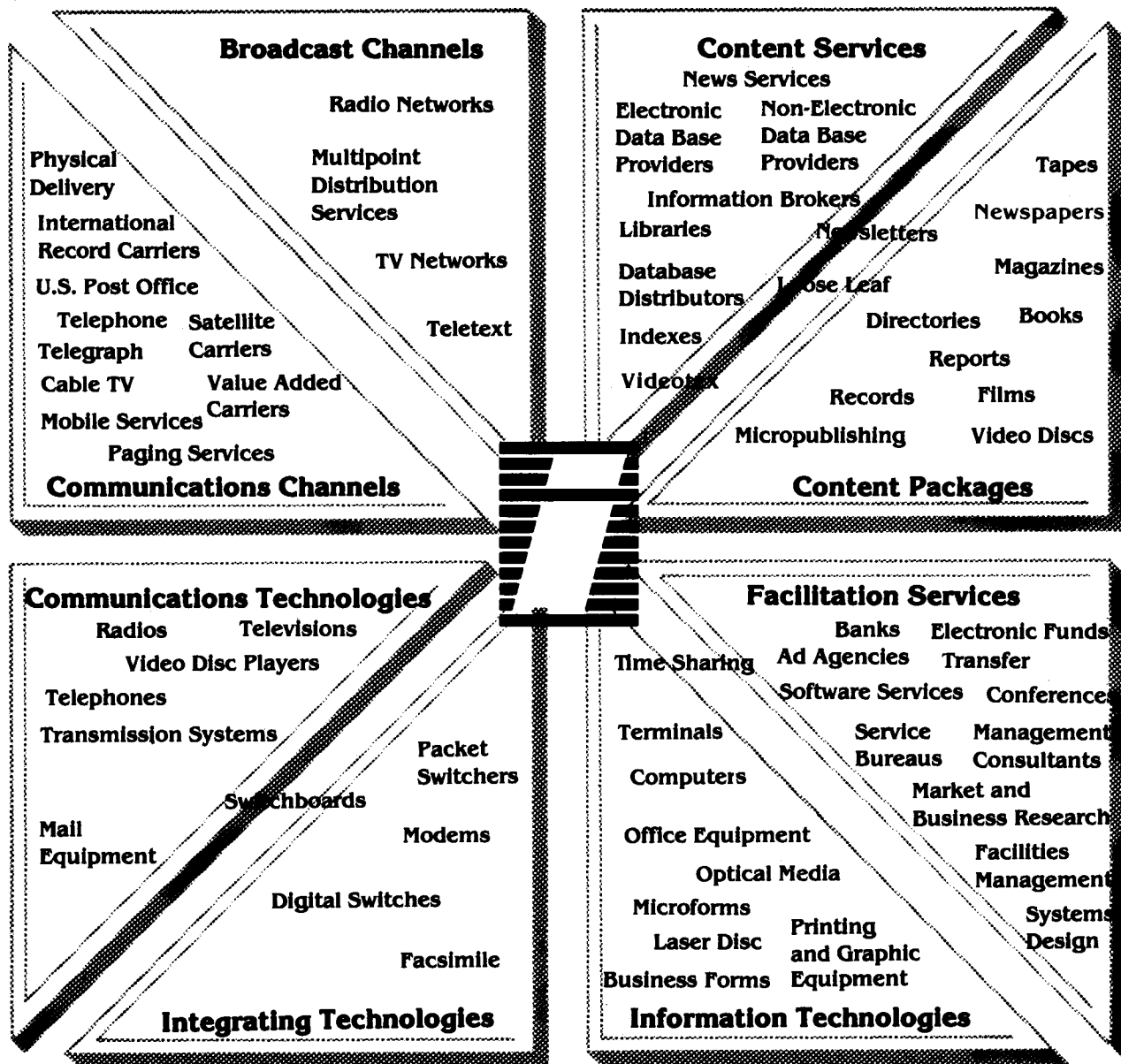
Source: Chris Burns and Patricia A. Martin, "The Economics of Information," Paper prepared for the Office of Technology Assessment. Contract # 433-9520, tables II-1, II-2, II-3, II-4, II-5, II-6, II-7, II-8, II-10, II-31, used with permission.

Given the changes in the information industry, particularly since the deregulation of AT&T, the definition has broadened once again. The definition used in this report holds that the information industry includes those

companies that are involved in the generation, packaging and/or distribution of information.

The breadth of this definition is illustrated in Figure A-3, the "information industry map" used by the Information Industry Association, based on an approach developed by the Harvard Program on Information Resources Policy. Content services include database distribution and videotext; content packages include newspapers, maps, and customer newsletters; facilitation services include operating system software, turnkey and database services, market research, and applications software; integrating and information technologies include facsimile equipment and micro and mini computers; communications technologies include telephones, and transmission equipment; and communication and broadcast channels include packet switching, cable TV, radio and TV stations, and private networks. To illustrate the major components of the information industry to the extent to which typical companies in the industry operate in one or more of the industry components, IIA President Paul Zurkowski has developed the grid shown in Figure A-4.

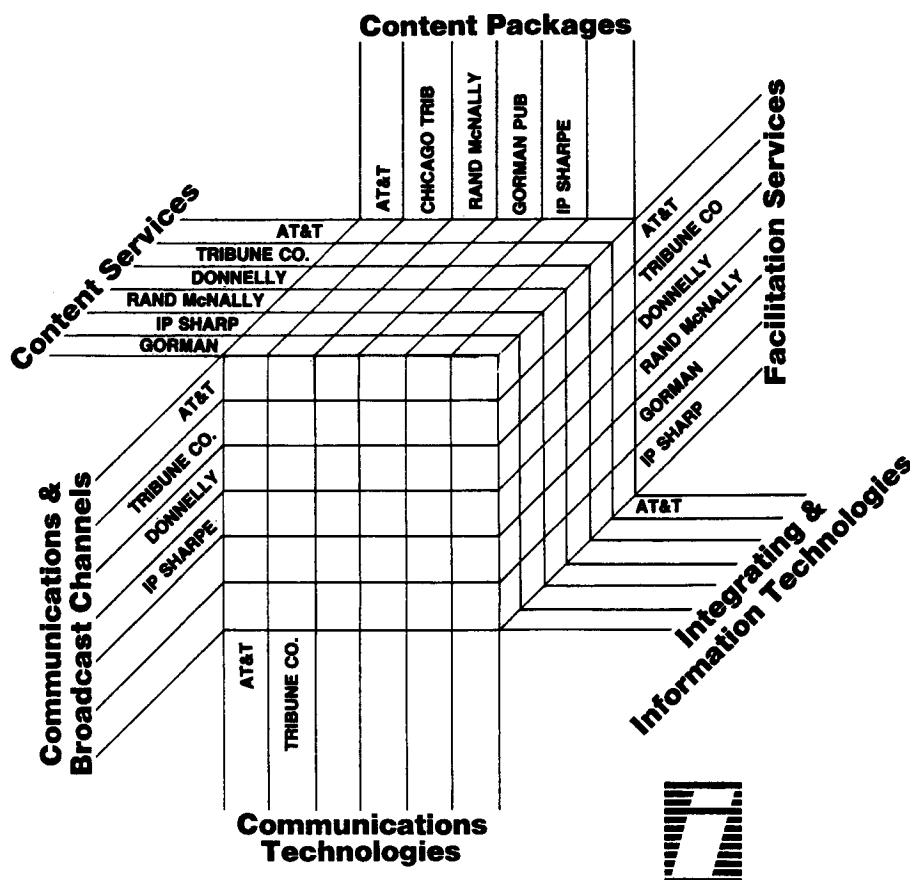
Figure A-3: Information Industry Map



Source: Information Industry Association

Figure A-4: Exploring the Information Industry Map

THE INTEGRATION OF THE INFORMATION INDUSTRY MAP



Source: Paul Zurkowski, "Infoword," Information Times, May 1986, p. 4.

The list below provides some of the products and services provided by the companies shown in Figure A-4 (6):

CONTENT SERVICES

AT&T
 UNIX Software
 Database Distribution
The Tribune Company
 Database supplier to Viewtex
 Public Access Videotex
R. R. Donnelly
 Electronistore
 Selectronic (list, etc.)
Rand McNally
 TDM online service
I. P. Sharp Associates Limited
 Information Service Online

CONTENT PACKAGES

AT&T
 Internal Publications
The Tribune Company
 Chicago Tribune
 NY Daily News
 Other Newspapers
Rand McNally
 Maps
Gorman Publishing
 Business Magazines
 Directories
I. P. Sharp Associates Limited
 Customer Newsletters
 Switching Equipment
 Telephones

COMMUNICATIONS AND BROADCAST CHANNELS

AT&T
 Packet Switching
 Private Networks
 800 Services
I. P. Sharp Associates Limited
 IPSANET Private Network
Tribune Company
 WGN Radio & TV Stations
 TV Stations
 Cable TV
R. R. Donnelly
 Rockford (Ill) Cablevision
 Donnelly Satellite Network

FACILITATION SERVICES

AT&T
 Videotex
 Operating Systems Software
 Data Management Services
 The Tribune Company
 Media Services
Rand McNally
 Turnkey Software &
 Database Services
 PC Software
 PC Database Distribution
 Software
 Financial Services and
 Database Management
 Services
Gorman Publishing
 Conferences
 Market Research
I. P. Sharp Associates Limited
 Time Sharing Services
 Electronic Mail
 Software
 Applications software for
 data management

INTEGRATING TECHNOLOGIES AND INFORMATION

AT&T
 Facsimile Equipment
 Micros and Minis

COMMUNICATIONS TECHNOLOGIES

AT&T
 Switching Equipment
 Telephones
 Transmission Equipment

In general, the notion that the information industry's boundaries will blur is consistent with a variety of forecasts. For example, electronically captured data on point-of-sale transactions will continue to be sold by the familiar market research companies. Yet before long, grocery store chains will provide their own data more readily. Likewise, large health care chains will become information providers to pharmaceutical and hospital supply firms directly off of their data bases. The actions of AT&T and the Regional Bell Operating Companies are a prime example of large companies moving to provide products or services in most of the six components in Figure A-3.

The electronic version of information and its future is of particular concern in this report. Defined as information transmitted electronically, the market is smaller. LINK Resources notes that sales of commercially available information delivered in electronic form accounted for nearly \$1.6 billion in user expenditures in 1984 (7). This \$1.6 billion is made up of a variety of types of databases: business and consumer credit; financial and professional; economic and industry; legal and government; and others. Michael Tyler, President of CSP International, focusing on the slightly larger arena of electronic publishing, argues that the \$2.3 billion in expenditures in 1984 will grow to \$6 billion in 1990 (8). Both Tyler and LINK Resources note that the relative importance of the players in the industry is changing.

LINK Resources forecasts that the electronic information dollar will shift somewhat between 1984 and 1989. System operators will have the dominant share - just over 50 percent of revenues. Information providers will rise from 22 to 28 percent. Integrators, particularly gateway services, will rise from under 2 percent to over 8 percent. This will allow more smaller databases to get marketing exposure and have billing and collection services provided. The actual communications revenues, with the unit cost of communications dropping, will shrink from 22 percent to 11 percent.

However, by 1990 a significant percentage of electronic information will be delivered physically rather than on-line as floppy disks and, increasingly, CD-ROM technologies are used, according to related forecasts from LINK Resources (9). In thinking about the relative proportion of physical vs electronic delivery of electronic information in the year 2000, a critical issue is the evolution of networks. Local on-site storage of massive amounts of data will prove useful for certain applications that are not time sensitive or frequently updated. The economics of producing and distributing the database become the key issues. It is plausible that the communications networks will develop for both business and home applications with sufficient power and low price that the preponderance of storage and expert systems will continue to reside in the network. This would lead to a relatively constant proportion, say 30 percent of the dollar volume, of the electronic data stored on-site through the 1990's. This assumes that the massive storage technologies described in Section 2 become common. While virtually all phone users will be part of the ISDN network, the relative importance of the various network operators e.g., the RBOC's, private, cable, microwave and satellite networks may vary from region to region.

NOTES

1. Charles Jonscher, "Information Resources and Economic Productivity," Information Economics and Policy. No. 1, (North-Holland, 1983), pp. 20, 26, 27.
2. Marc Porat, The Information Economy: Definitions and Measurement, Office of Telecommunications, Special Publication 77-12, (May 1977).
3. Joseph E. Laird, Jr., Innovation in Information (Hambrecht & Quist, 1986), p. 3.
4. Information Industry Association, The Business of Information 1983, as cited in Paine Webber Mitchell Hutchins Inc., The Information Industry: A first Quantitative Analysis Prepared With the Cooperation of the Information Industry Association, (March 12, 1984), p. 3.

5. Paine Webber Mitchell Hutchins, op. cit. p. 3.
6. Paul Zurkowski, "Infoworld," Information Times, (May 1986), pp. 4.
7. LINK Resources, Electronic Information Industry Forecast, 1984-1989, (Electronic Information Program, 1984).
8. Michael Tyler, "The Future of Electronic Publishing," Electronic Publishing Plus, forthcoming.
9. LINK, op. cit.

APPENDIX 3: PERSONS INTERVIEWED

We wish to thank those individuals listed here who we interviewed during the course of this project. The length of time of the interviews varied among those on the list. Many were interviewed in conjunction with the 4 IIA meetings in 1986 in Boca Raton, Denver, Palo Alto and Cambridge. Not listed by name were the 120 individuals who took part in our workshops or briefings at each of those meetings. In addition to those listed here, there were also groups of experts in four different organizations who met to advise us at various stages of the project. We particularly want to acknowledge their help and the assistance of the person at each organization who arranged for the review session - Dataquest - Ralph Finley, The Pacific Telesis Group - Vernon Tyreman, LINK Resources - Steven Sieck, and the Congressional Office of Technology Assessment - Frederick Weingarten.

While the individuals listed below, as well as those in the organizations mentioned were essential to the development of this report, their listing here does not indicate that they (or their organization, listed for identification purposes) agree with the report. We bear responsibility for what has been produced.

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Daniel M. Sullivan
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Sheridan Tatsuno
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GLOSSARY

Ada	Advanced language initiated by the Department of Defense to become its common programming language.
"Agent"	Pre-instructed expert system that searches virtually all information sources according to a user's interests and provides the results in whatever formats are most effective.
AI	Artificial intelligence.
ANSI	American National Standards Institute.
Artificial Intelligence	The ability of a machine to perform functions normally associated with human intelligence, such as comprehending spoken language, making judgments and learning.
Baud	A measure of transmission speed equal to the number of signal changes per second.
BIPS	Billions of instructions per second; a measurement of computer processing power.
BPS	Bits per second; a measurement of data transmission speed equivalent to baud when one bit is depicted by one signal change.
CD	Compact disk.
CDI	Compact disk interactive; optical systems being developed to handle video, audio and textual data with a computer chip built into the player so it can operate independently from a microcomputer.
CD-ROM	Compact disk read-only-memory.
CPU	Central Processing Unit; computer part composed of an arithmetic logic unit, a control unit and a small amount of memory; the CPU interprets and executes instructions.
DARPA	Defense Advanced Research Projects Agency of the Department of Defense.
Descriptive Forecast	An estimate of what might happen.
Differentiating factors	The key aspects which distinguish among alternative scenarios.

Digital	Pertaining to the representation, manipulation or transmission of information by discrete, or on-off signals.
Driving forces	The principal forces which lead to different evolutionary paths in the scenarios.
E-beams	Electronic beams; these may be used in the future in place of the current photon beams in optical storage (e.g., CD-ROM) to provide much greater storage capacity.
E-Comms	Electronic communications systems.
EDGAR	Electronic Data Gathering, Analysis and Retrieval. The proposed project of the Securities and Exchange Commission to use a private-sector vendor to automate parts of their informations systems.
E-mail	Electronic mail; a generic term describing the use of digital and other technologies such as facsimile in the generation, transmission and distribution of messages.
Ergonomics	Equipment design that attempts to optimize human effectiveness.
ESOP	Employee stock ownership plan.
Expert systems	AI programs generating advice and making limited decisions within specialized subjects by drawing on a knowledge base and decision rules developed through studies of human experts.
Extrapolative projections	These identify likely future extensions of current trends, which would be surprising if they did not occur; a "no-brainer" forecast.
Femtosecond	10 to the -15th power of a second.
Facsimile transmission	A technique of transmitting and receiving pages (text, diagrams, pictures) over telecommunications links.
Fiber optics	The science and technology dealing with the transmission of light through extremely thin fibers of glass, plastic or other transparent material.
Future	An image of what may be, composed of a set of elements whose interactions are shaped largely by a set of driving forces. Also called a macrosenario.

GaAs	see Gallium arsenide.
Gallium arsenide	The basis for integrated circuits having higher speed, lower power consumption, radiation resistance and lightwave technology compatibility.
Gigabyte	A billion bytes.
GIS	Geographic information systems.
Hypertext	A device that sorts, compiles, summarizes and presents information from multiple sources in the styles most effective for the knowledge level and interest level of the user.
Information millennium	The time from the year 2000 to 3000, during which information is the key strategic resource.
Information revolution	The dramatic changes in information technologies, the state of knowledge, and the use of information in society occurring in the 20th century and the beginning of the 21st century.
Information society	A society that reflects the growing importance of information in the shift from manufacturing jobs, in the growth of information purchases, in the importance of information in business and personal life, and in the enhanced level of information built into products.
Integrated circuit	An electronic circuit all of whose components are formed on a single piece of semiconductor material.
ISDN	Integrated service digital network allowing computer and voice data transmission over the telephone system.
Josephson Junction	Experimental class of integrated circuit designed to operate at extremely high speeds and at extremely low temperatures.
LAN	Local area network in which computers are physically connected to share resources.
Mainframe	The largest type of computer, having more than 32 bits per microprocessor, and usually capable of serving multiple users simultaneously.
MCC	Microelectronics and Computer Technology Corporation; a consortium of major information technology companies organized to pursue joint R&D projects.

Magnetic bubble storage	Storage consisting of a thin layer of garnet material containing magnetic domains. When an external magnetic field is applied, the domains look and behave like bubbles which are manipulated to represent information bits.
Microcomputer	A desktop or portable computer, traditionally having an 8 to 16 bit microprocessor and designed for a single user. Microcomputers are rapidly becoming more powerful, blurring the distinction between them and minicomputers.
Minicomputer	A midsize computer smaller than a mainframe, traditionally having a 16 or 32 bit microprocessor. Minicomputers are rapidly becoming more powerful, blurring the traditional distinctions between them and mainframe computers.
MIPS	Millions of Instructions Per Second; the unit for computer-processing power.
MIS/EDP	Management information systems/electronic data processing.
MITI	Japan's Ministry of International Trade and Industry.
Molecular electronics	Technology using man made molecules to replace conventional transistors, logic gates, capacitors, resistors and the other units that comprise today's integrated circuit.
Natural Language processing systems	Systems allowing humans and machines to interact in natural languages such as English, Russian or German rather than in a computer language.
Neural networks	Simulation of operations of the nervous system using parallel processing circuits; "synthetic neurobiology."
No-Brainer Projection	See extrapolative projection.
Normative forecast	A forecast of a desirable future.
OCR	Optical character reader or optical character recognition; machine recognition of printed or written characters through scanning and sensing by photo-electric transducers.
OMB	Office of Management and Budget (U.S. Government).
OSI	Open systems interconnection standards to allow almost any system to communicate with any other system.

OTA	Office of Technology Assessment (U.S. Congress).
PBX	Private branch exchange; a telecommunications switching mechanism, generally based on a stored program digital computer located at the site of a particular organization.
Packet switching	The separation of messages into small units called packets that are transmitted by the sending station and reassembled in correct data order by the receiving network station.
Parallel processing architecture	Computer architecture using multiple processors capable of performing multiple operations at the same time.
Pixel	In computer graphics, a pixel is the smallest element of a display surface that can be independently assigned color or intensity.
PLATO	Control Data Corporation computer aided instruction system developed at the University of Illinois.
Plausible future	An image of the future composed of a set of forecasts which might reasonably occur.
Preferred future	An image of the future which is desired and sought after.
RAM	Random-access memory; a temporary internal storage whose contents can be retrieved and altered by the user.
RBOC	Regional Bell Operating Companies.
Read	The CPU process of examining data in memory or transferring data to memory from an input to an output medium.
ROM	Read-only-memory; permanent internal memory containing data or operating instructions that cannot be altered.
SR	Speech recognition; machine recognition of human speech.
Scenarios	Comprehensive, internally consistent descriptions of the future, in narrative and/or numerical form, based on specific assumptions about relevant forces (e.g., social, economic, political, ecological and technological) and their interactions. Scenarios of a specific industry include the key components internal to that industry as well as the forces in the broader environment.

SEC	Securities and Exchange Commission.
Secondary memory	Computer memory or storage where information is not lost when power is turned off, (e.g., magnetic tape, floppy disks, optical disks).
Semiconductor	A solid crystalline substance whose electrical conductivity falls between that of a metal and an insulator.
Sensory Systems	Image, vision or tactile systems that amplify the capabilities of robots or other automated equipment.
"Smart house"	A house with substantial computing power and intelligence built into its equipment and operation. Also, the efforts of the National Association of Home Builders to set standards for the wiring that will allow all types of electrical, communication and other equipment to be integrated.
Speech recognition	AI technology to allow computers to recognize and understand human speech.
Strategy	An orchestrated set of decisions over time designed to achieve specified goals and objectives.
Synthetic neurobiology	See Neural networks.
TDM	Time-division multiplexing; a channel sharing technique in which each station has access to transmit at certain times, under certain rules enforced by a network controller or the interface protocols.
Videotext	Electronic information and communications systems with two way capabilities allowing the user to interact with the system. Systems have databases of textual and graphic "pages" of information that can be accessed over telephone lines or cable television, and some services can be accessed by personal computer. Some systems may offer transactional services, alarm and meter readings, games; and other features.
Voice synthesis	AI application that allows computers to generate human speech.
von Neumann architecture	"Serial" computer architecture in which instructions and data are stored in memory and everything is processed sequentially, through a single adder/subtractor.

Wafer	A thin, round slice of semiconductor material, usually silicon, on which hundreds of chips are made at once.
Wafer-scale integration	Increasing the number of components per chip using pure semiconductor materials and defect-free circuits.
WORM	Write-once-read mostly; storage devices allowing users to write but not erase.
X-ray lithography	Method of etching chips with small line widths by X-ray.

About the Authors

Clement Bezold, Ph.D., is Executive Director of the Institute for Alternative Futures and President of Alternative Futures Associates. A political scientist and futurist his books have dealt with the future of work, health, government and the legal system. He is a frequent speaker on the future and consultant to state and local governments, state legislatures, and major corporations, particularly in the health field.

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About the Institute for Alternative Futures

The Institute for Alternative Futures is a non-profit organization founded by Clement Bezold, Alvin Toffler and others to aid governments and organizations in thinking about and choosing their future. IAF works with community and government groups throughout the U.S., as well as trade associations to plan more wisely their preferred future. In Congress IAF runs "foresight seminars" for Congressional staff to assist them in developing more strategic views of their field. IAF publishes a variety of books and reports. Its book The Future of Work and Health has been named one of the top 10 books in 1986 in the field of health by American Health magazine. For more information contact IAF at 1405 King Street, Alexandria, VA 22314, (703) 684-5880.

About the Information Industry Association

The Information Industry Association is a full service trade association representing over 460 companies pursuing the business opportunities associated with the creation, distribution and use of information. The IIA membership encompasses the entire spectrum of the information industry, including traditional and electronic publishers, database providers, financial information vendors, interactive electronic services and electronic mail companies, computer manufacturers, and telecommunications providers. For further information, contact IIA at 555 New Jersey Avenue, N.W., Washington, DC 20001, (202) 639-8262.

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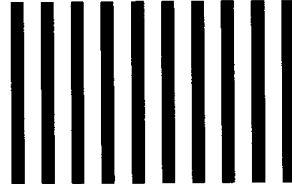
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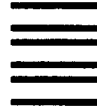


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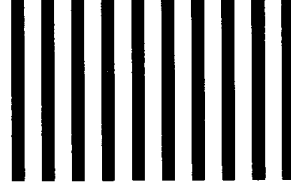
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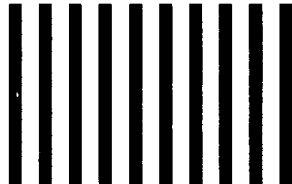
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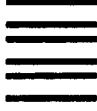


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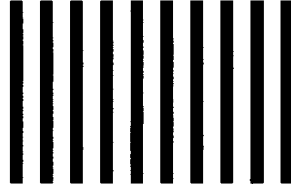
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